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# SPECTRA OF REFLECTED SOLAR ENERGY 0.4 TO 2.4 MICRONS CLOUDS, SNOW, FIELDS

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SPECTRA OF REFLECTED SOLAR ENERGY 0.4 TO 2.4 MICRONS  
CLOUDS, SNOW, FIELDS

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May 1971

GODDARD SPACE FLIGHT CENTER  
Greenbelt, Maryland

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# SPECTRA OF REFLECTED SOLAR ENERGY 0.4 TO 2.4 MICRONS CLOUDS, SNOW, FIELDS

## I. INTRODUCTION

During the flights of Nimbus 3 and in preparation for the flight of Nimbus 4 a number of spectra of reflected energy were measured utilizing a filter wedge spectrometer flown on a NASA C-47 and B-57B aircraft. The spectrometer was an advanced version of the type described by Hovis, Kley and Strange (1) in that it covered the spectral range from 0.4 to 2.4 microns utilizing two 360° wedge composites. One 360° wedge consisted of two 180° halves covering 0.4 to 0.7 and 0.65 to 1.3 microns respectively. The other 360° wedge covered 1.2 to 2.4 microns. A change in energy scale is utilized at 1.4 microns to enable detail to be seen in the 1.4 to 2.4 micron spectral range.

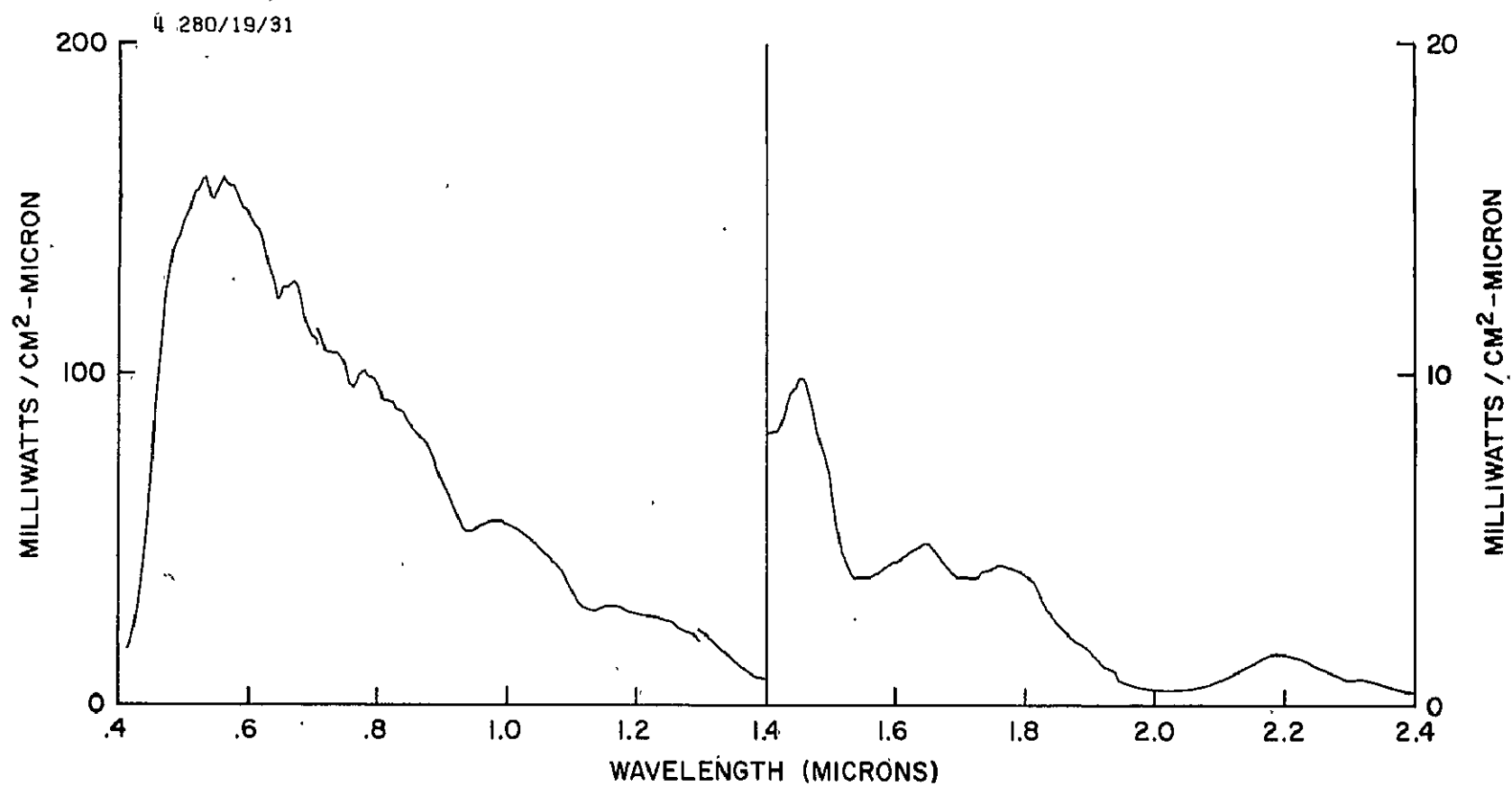
These data were collected for correlation with the daylight channel of the Nimbus 3 HRIR and to estimate gain settings for the Nimbus 4 Filter Wedge Spectrometer Experiment. The spectra were utilized for the purposes stated but have also aroused considerable interest among persons in various disciplines who have seen them. Accordingly they are gathered together here for use by interested parties.

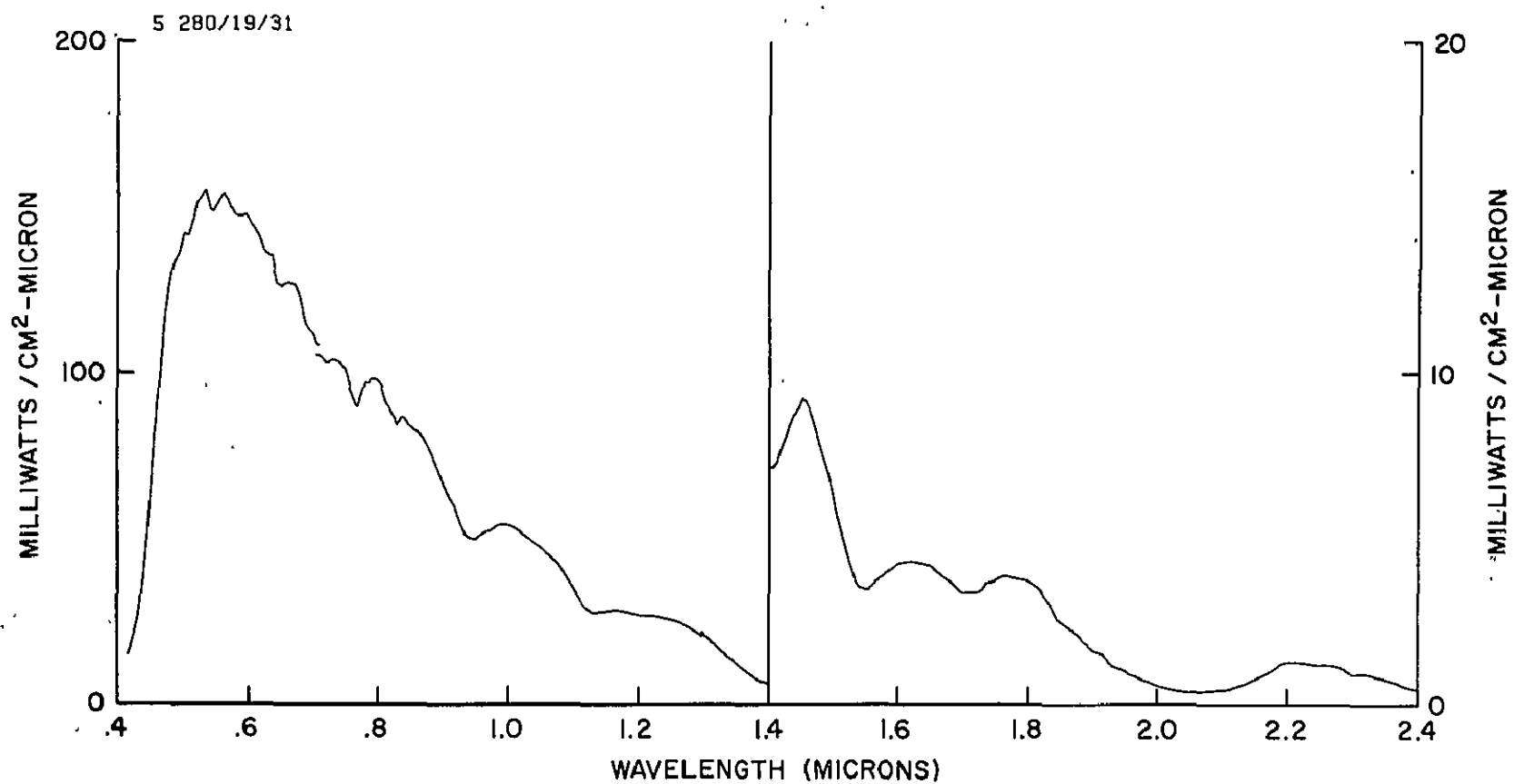
Each set of spectra is labeled with the Julian data of the year and a time as produced by a time code generator onboard the aircraft. Each group of spectra is preceded by a short description of the conditions and target. Altitudes given, except for radar altimeter readings, are referred to mean sea level.

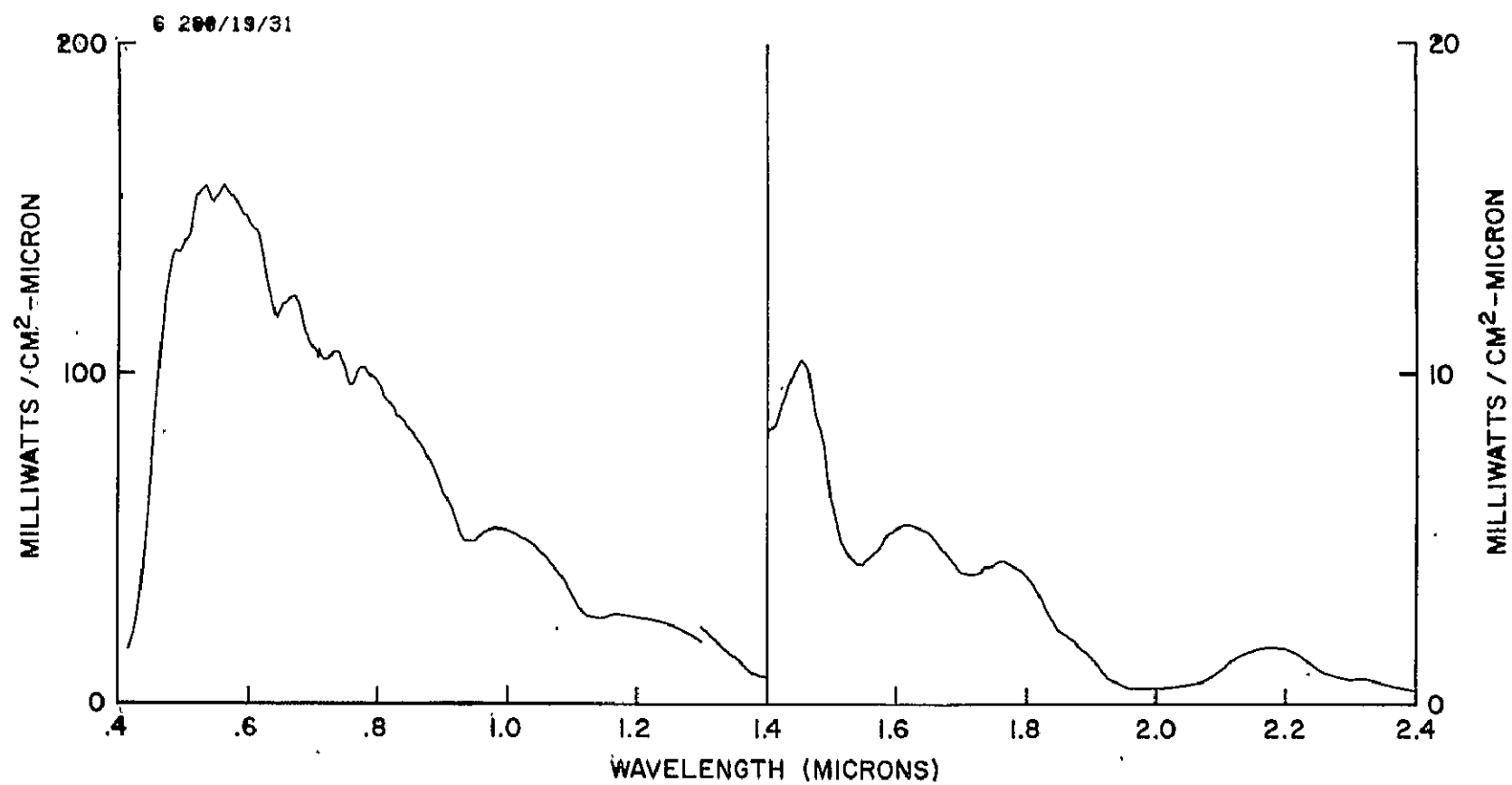
## II. CIRROSTRATUS DECK

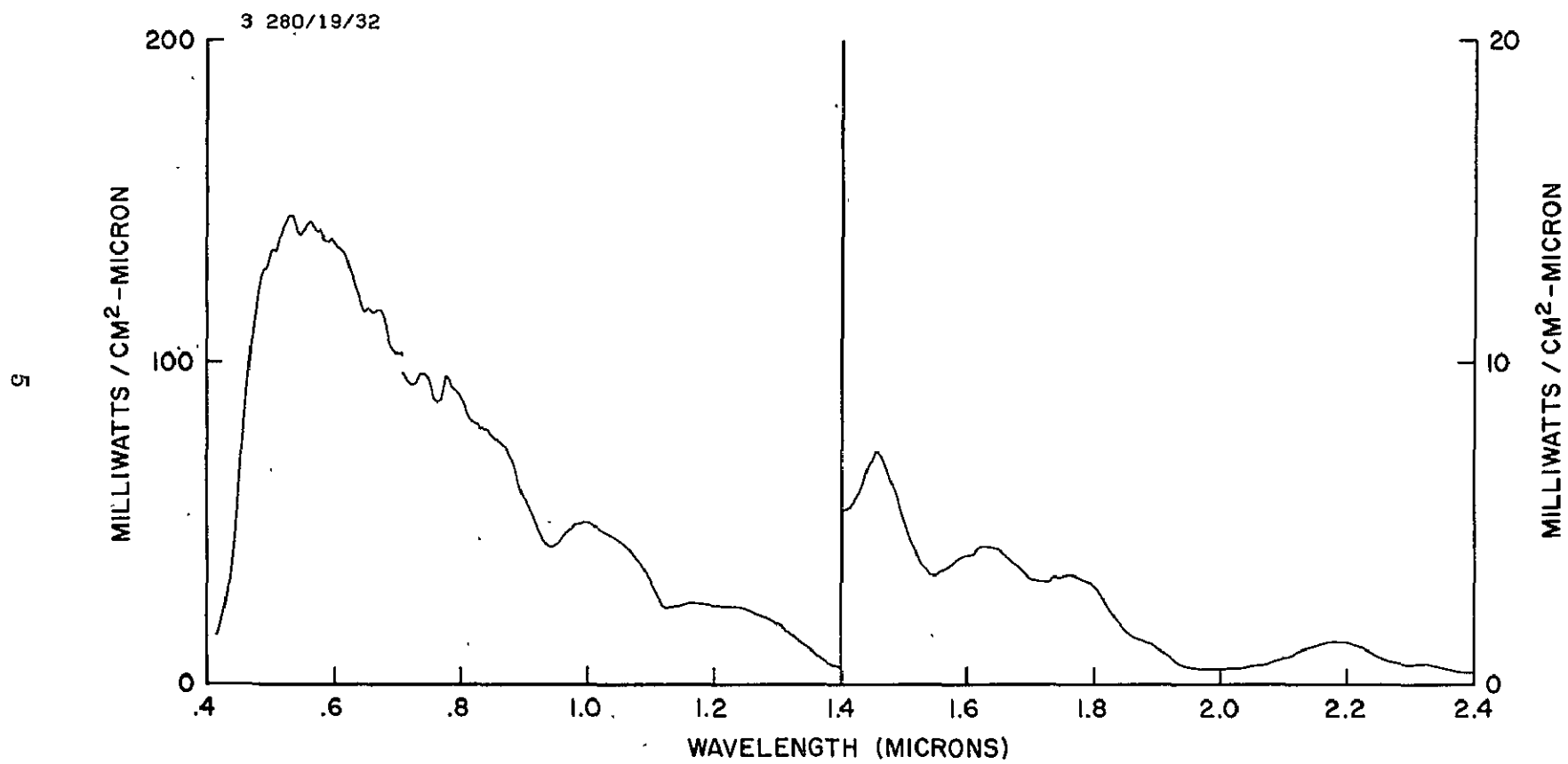
The spectra in this section were taken from the NASA B-57B aircraft from Lewis Research Center in Cleveland, Ohio. The plane was flown by Byron Batthauer of Lewis Research Center. The day was October 7, 1969 (Julian Day 280) and were taken between 19hrs. 31 mins. and 19hrs. 36 mins. Universal Time.

The cirrostratus deck was thick and extending Easterly from a well defined edge just east of Cleveland. A commercial jet airliner reported the top at 37,000 ft. (11.3 km) while the B-57B aircraft was above at 43,000 ft. (13.1 km)..

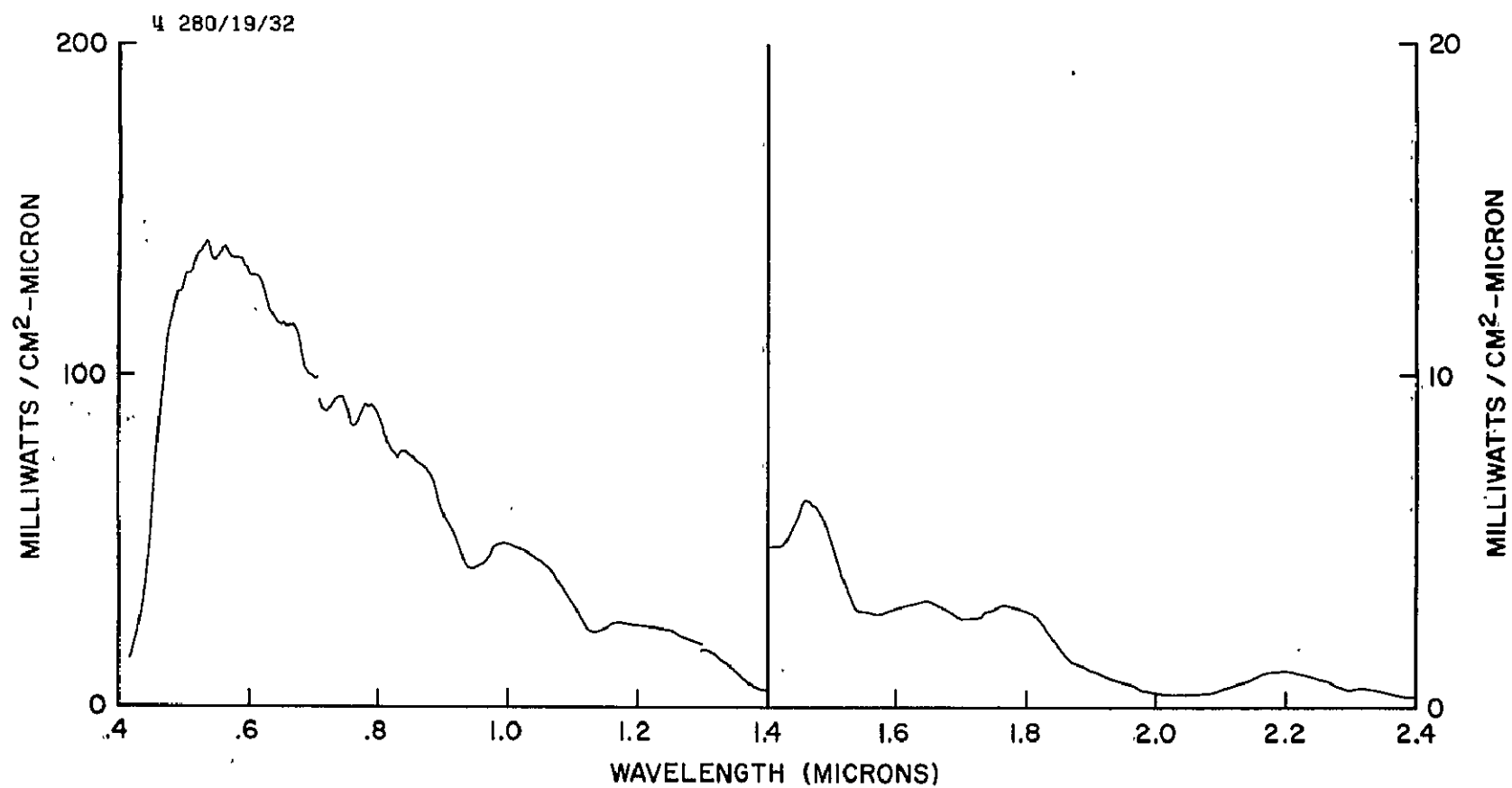


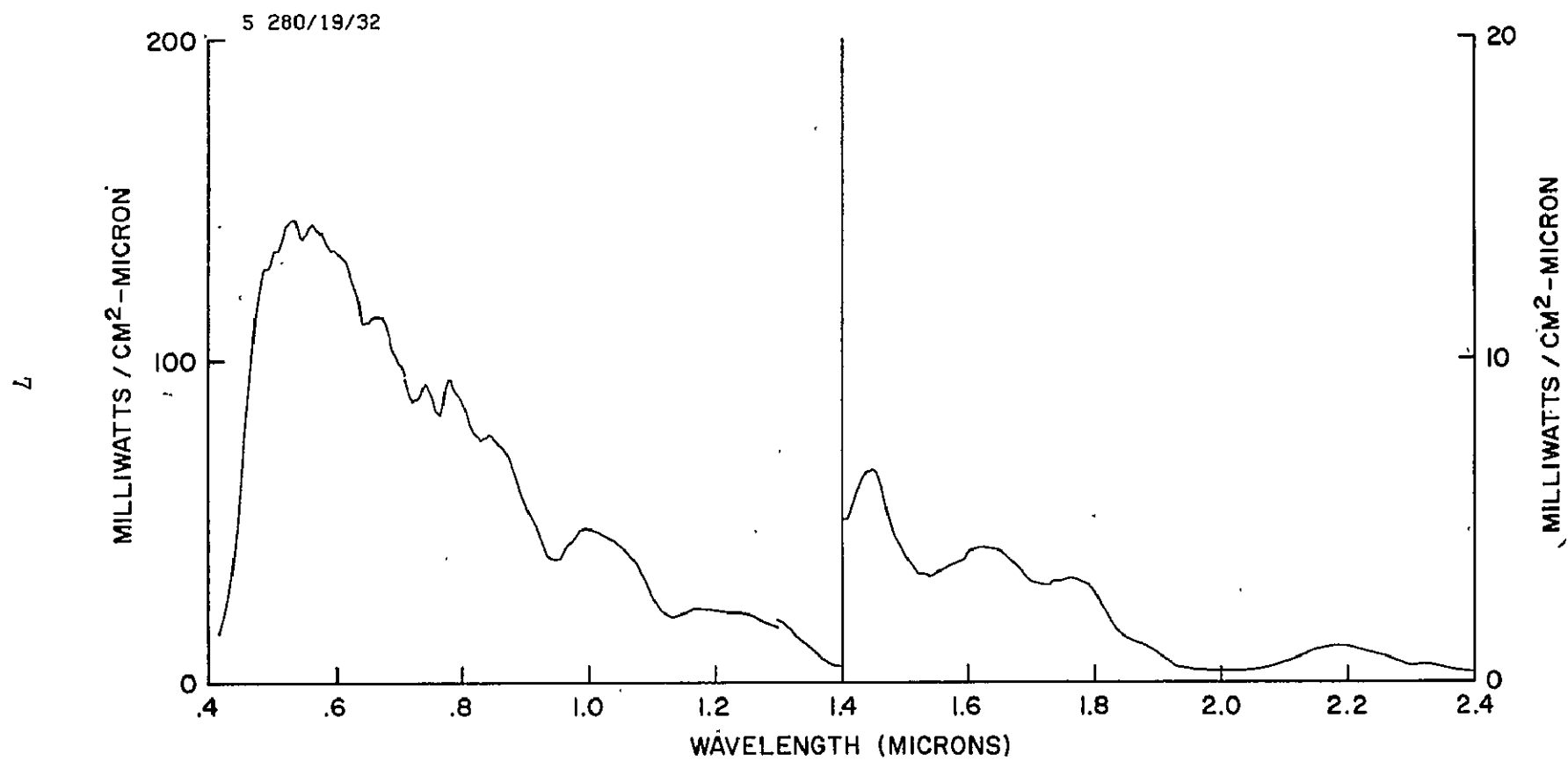


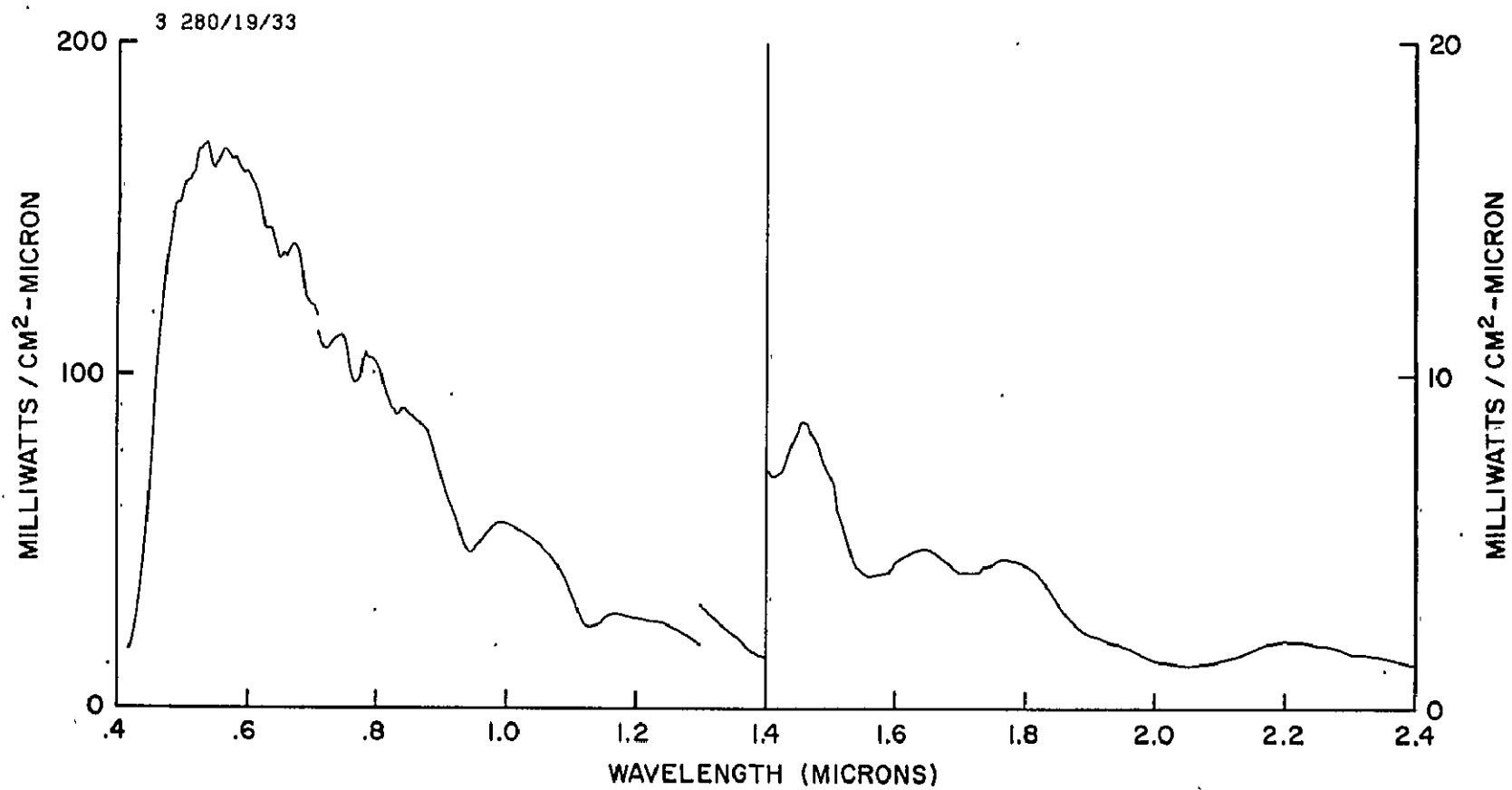


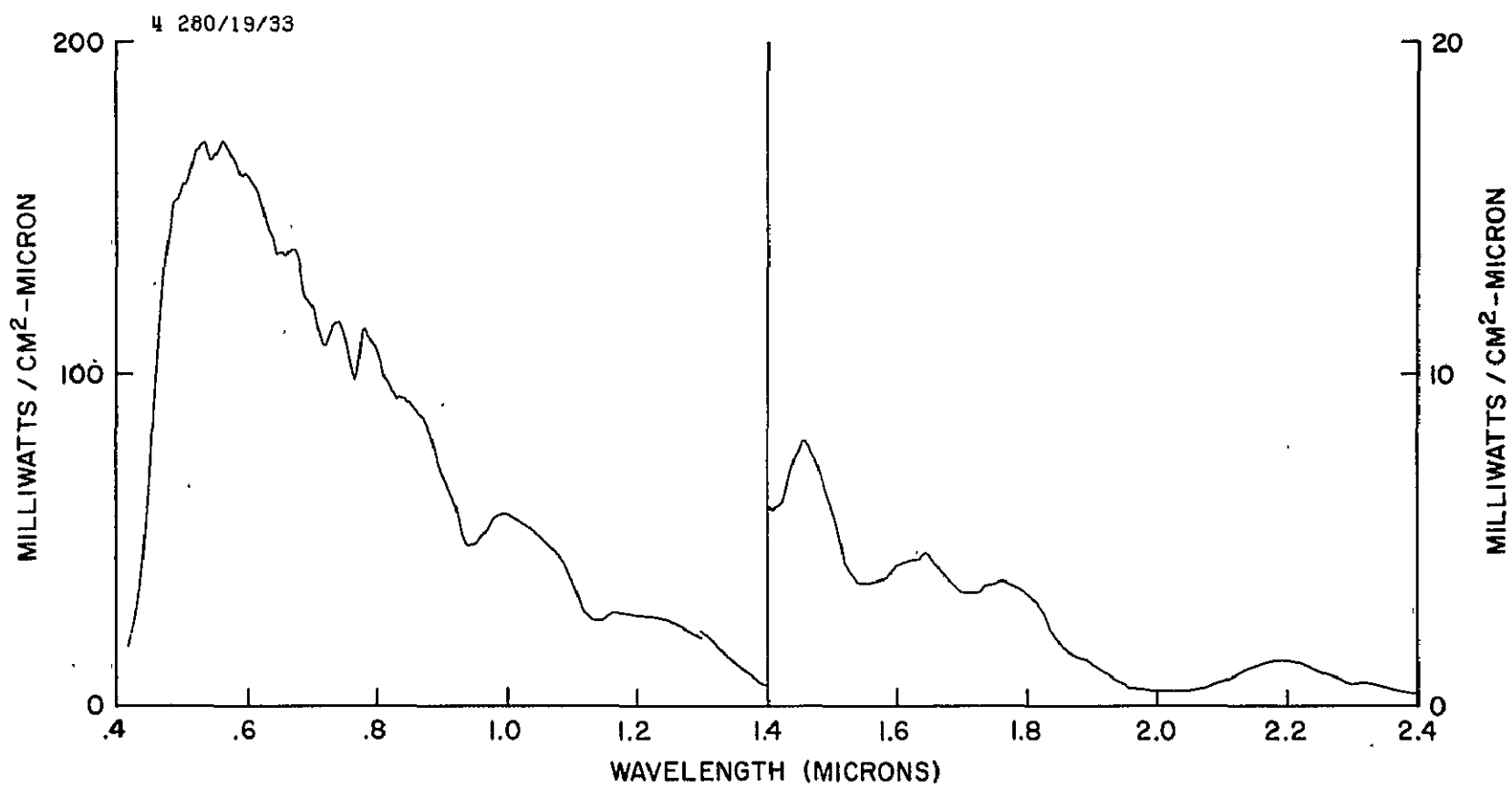


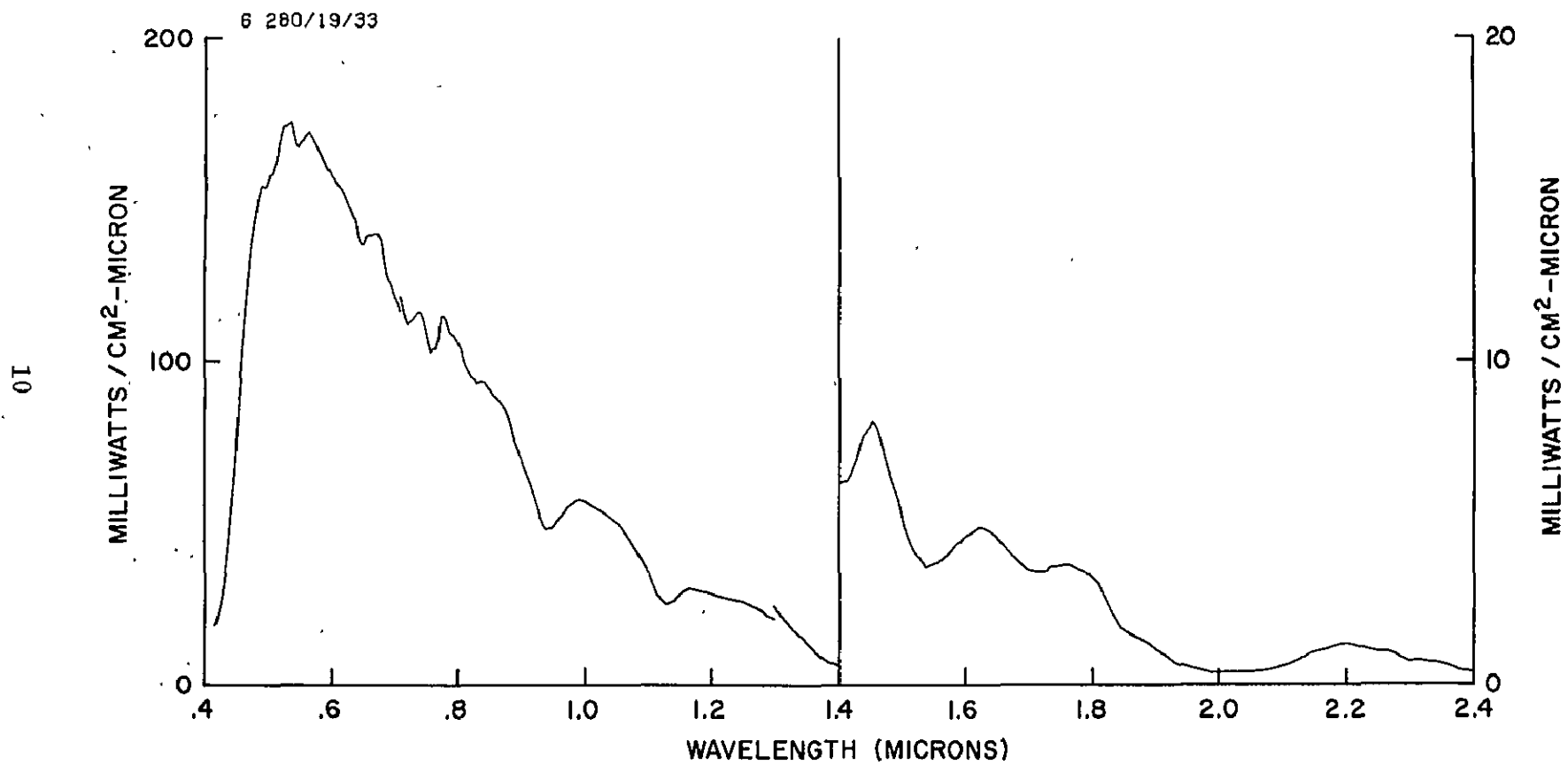


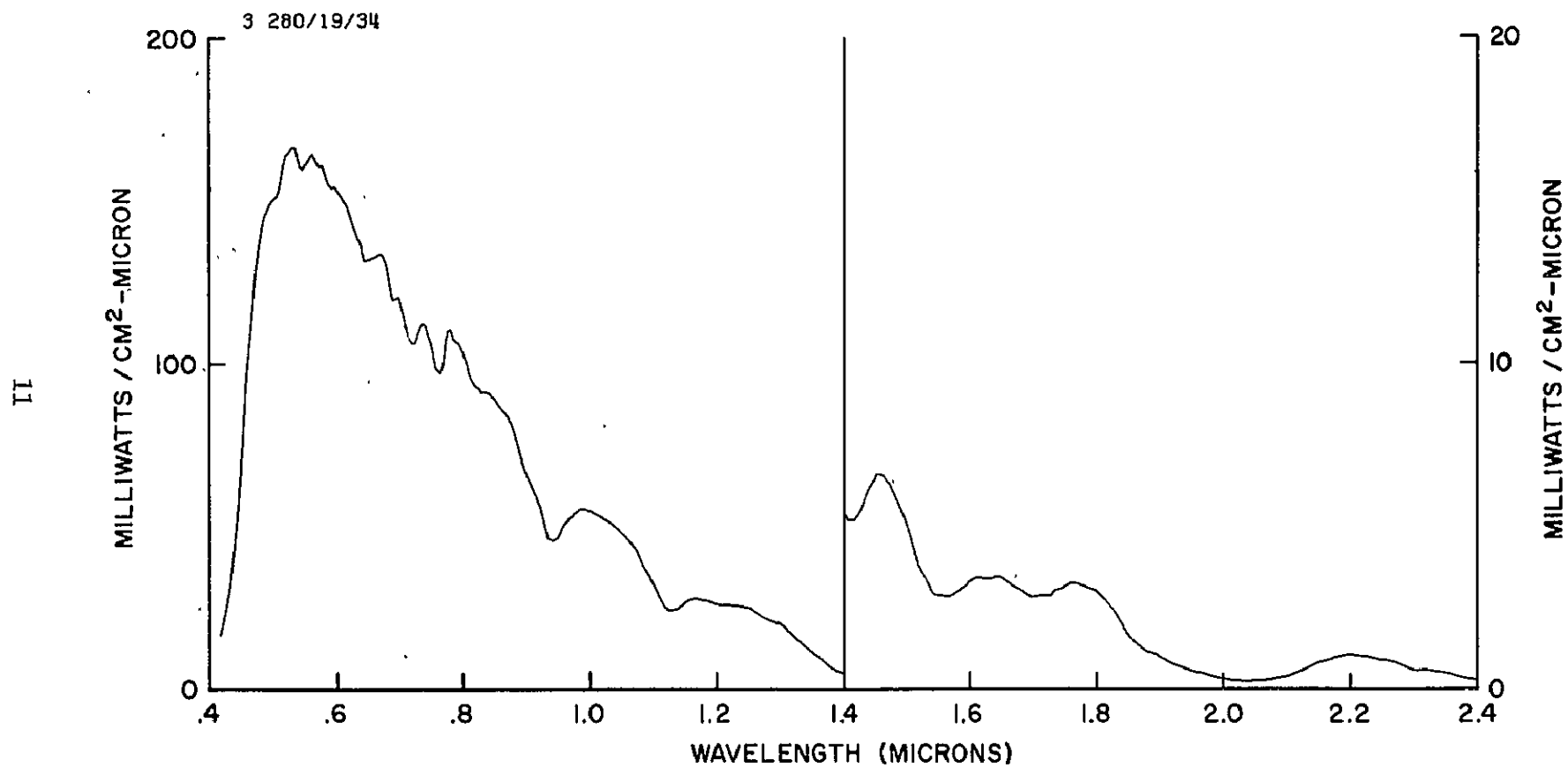


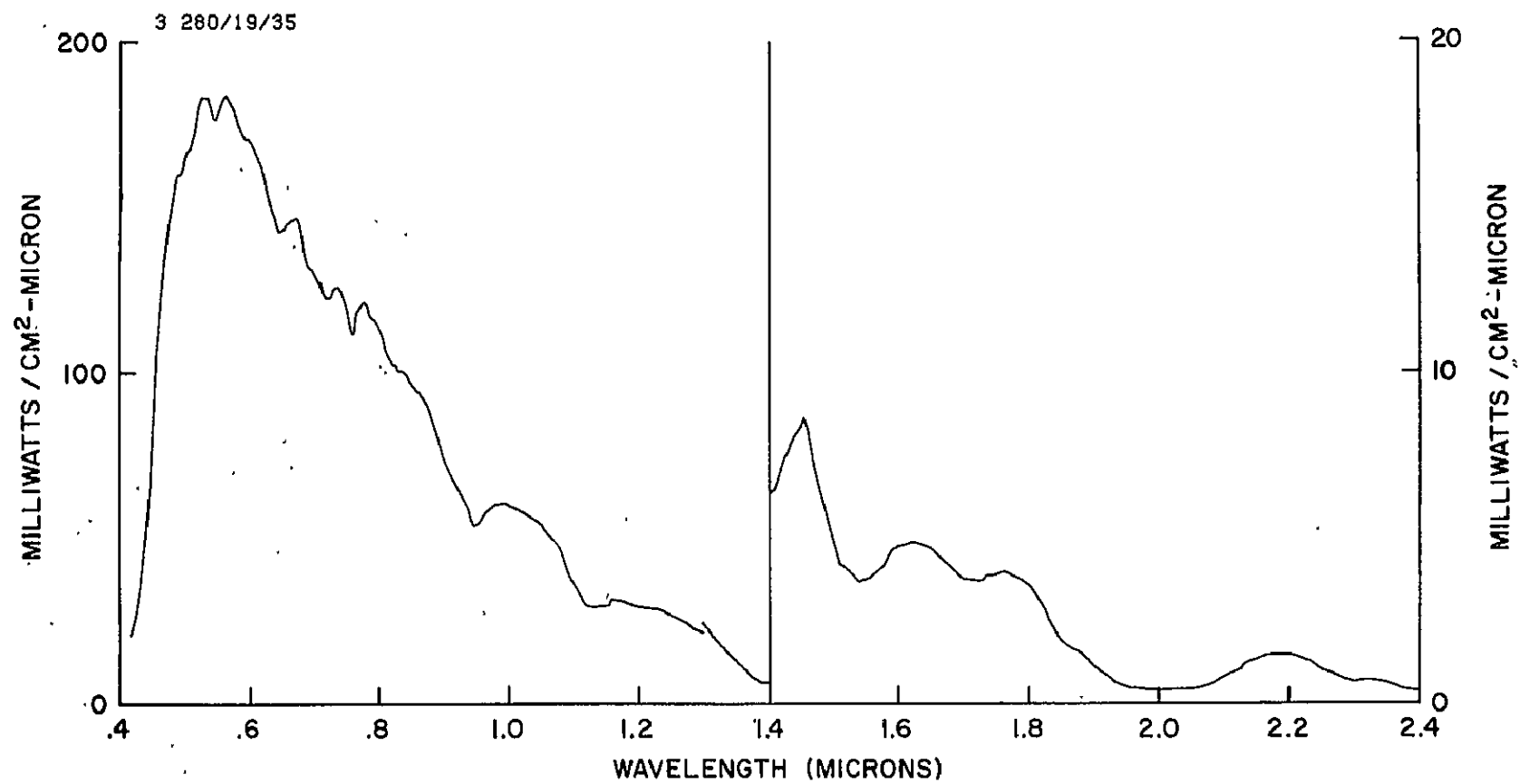


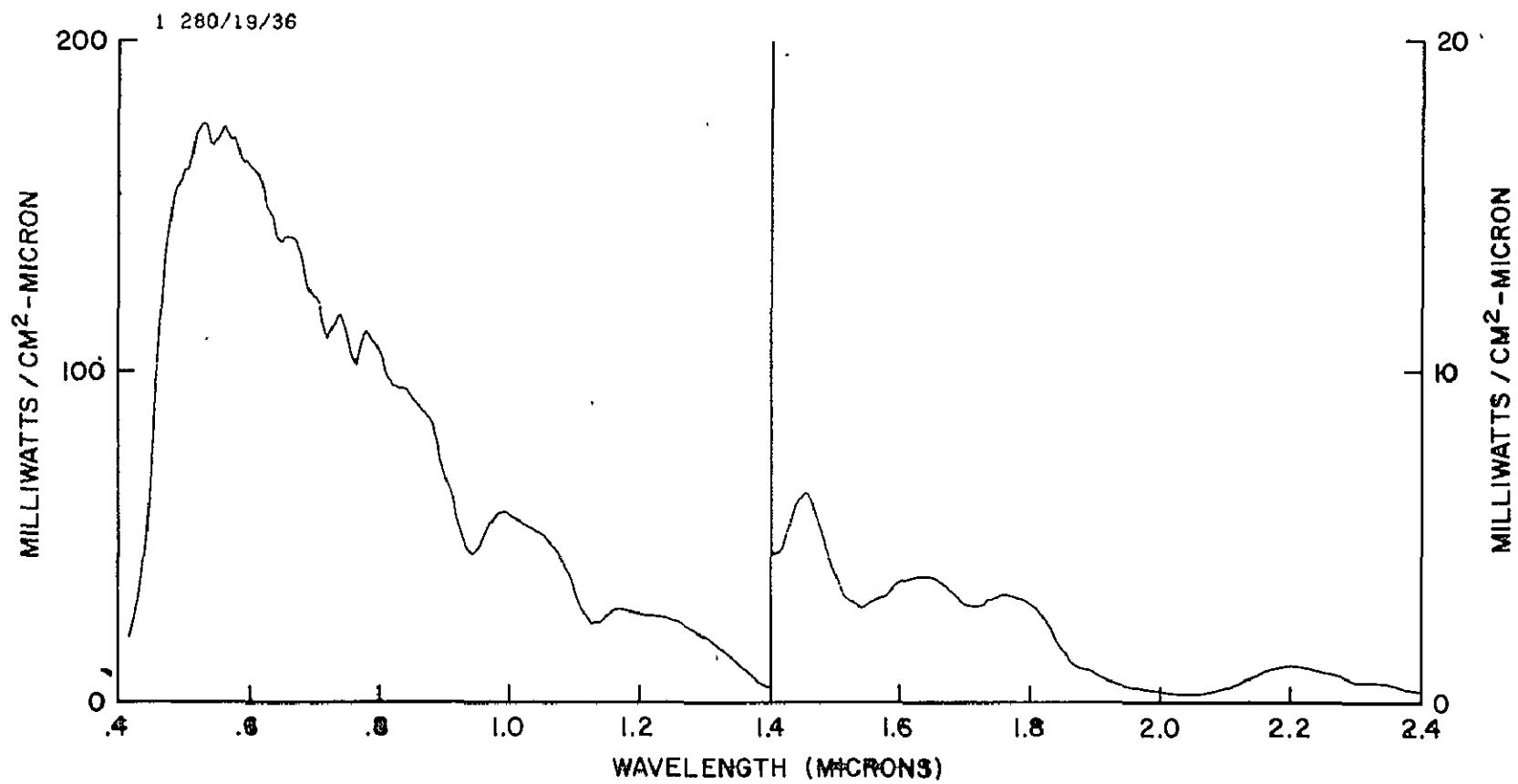




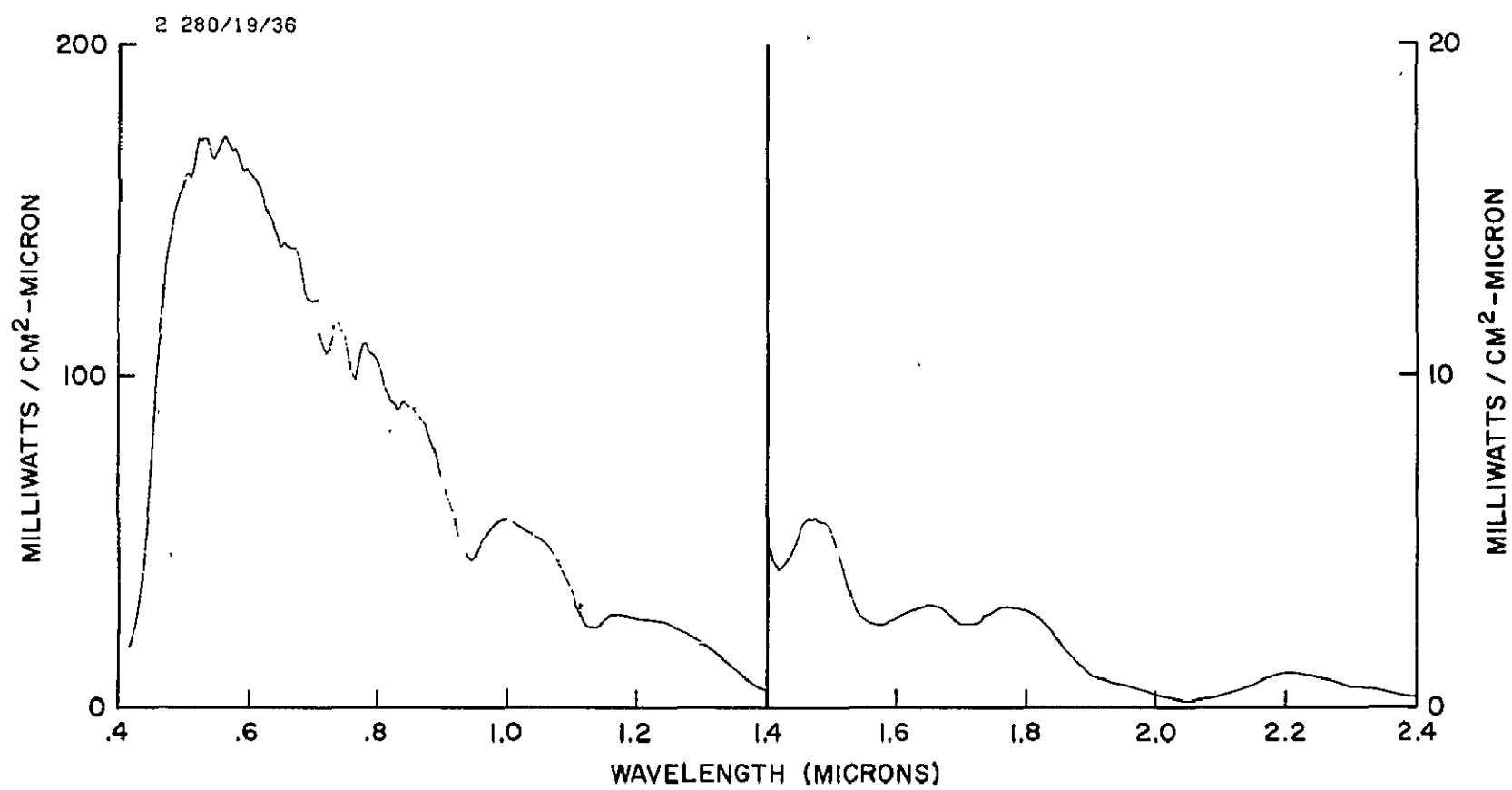








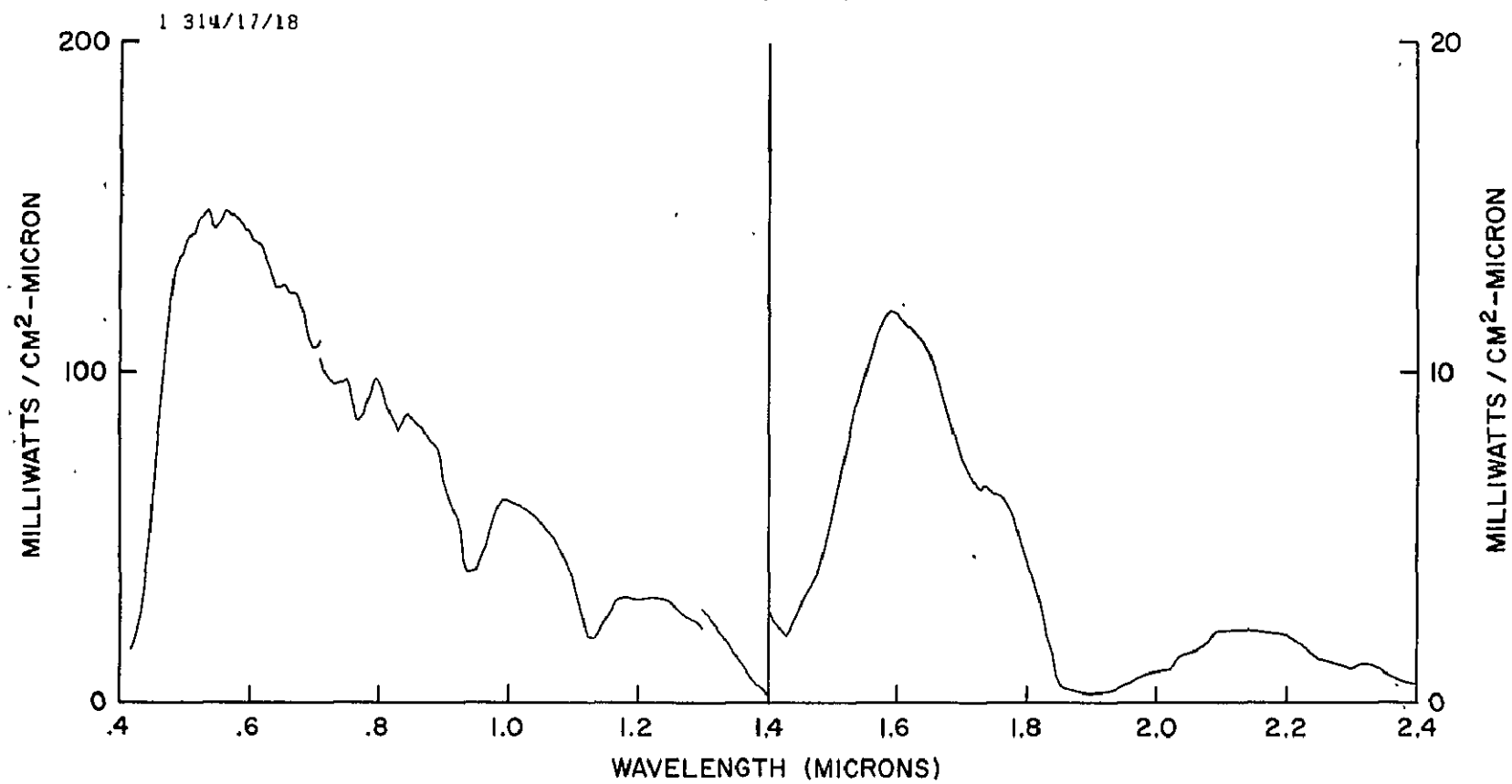


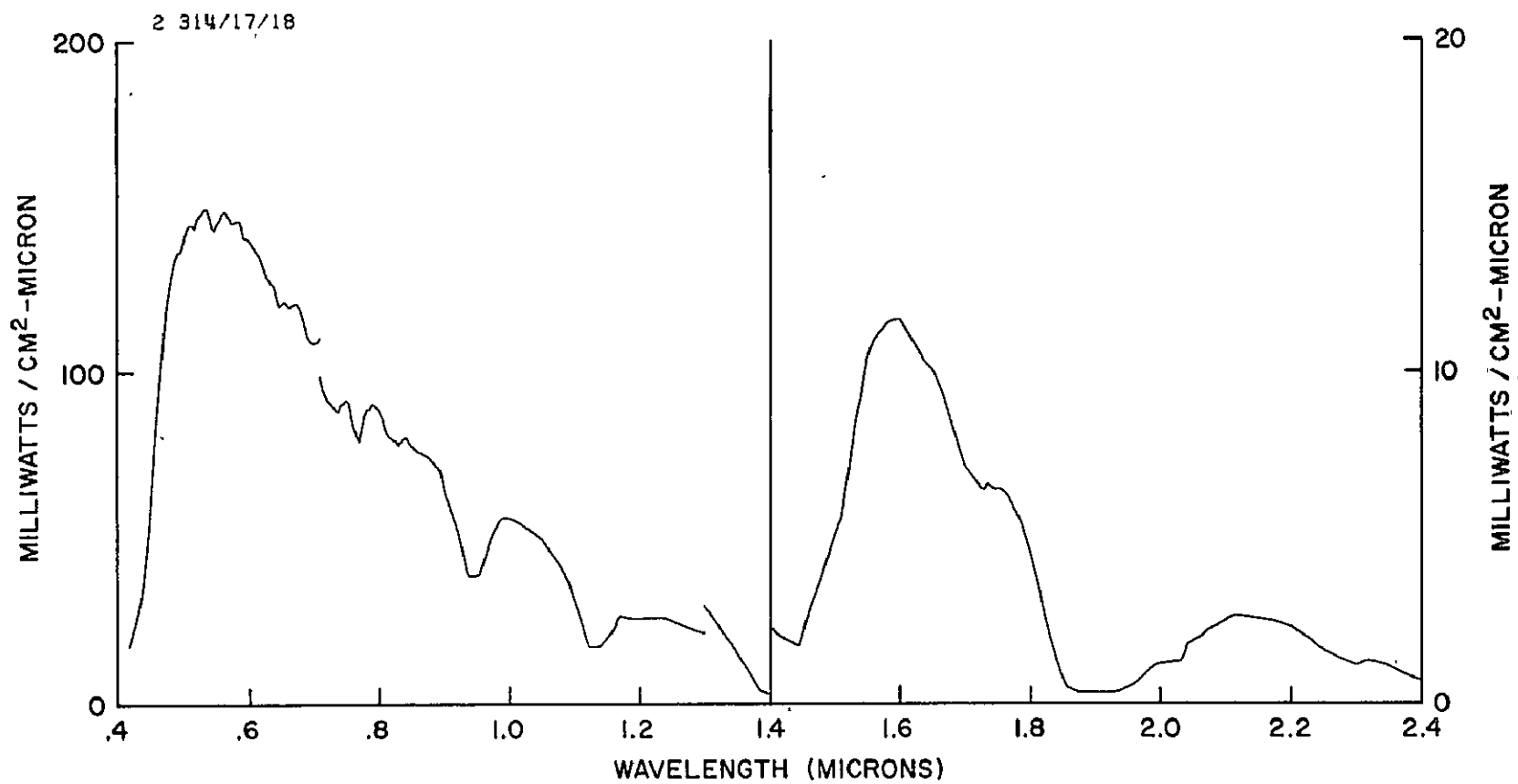


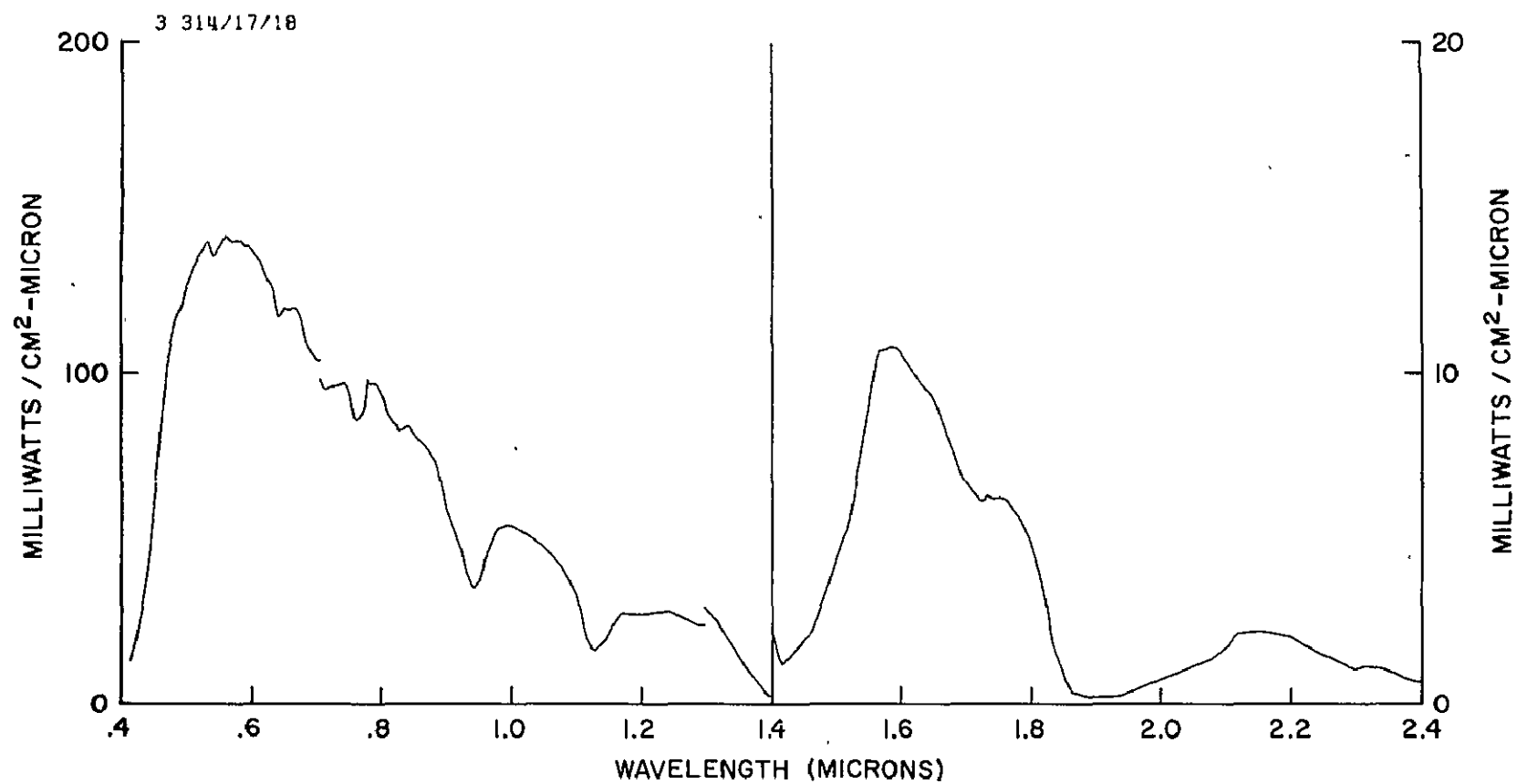
### III. STRATUS CLOUD DECK

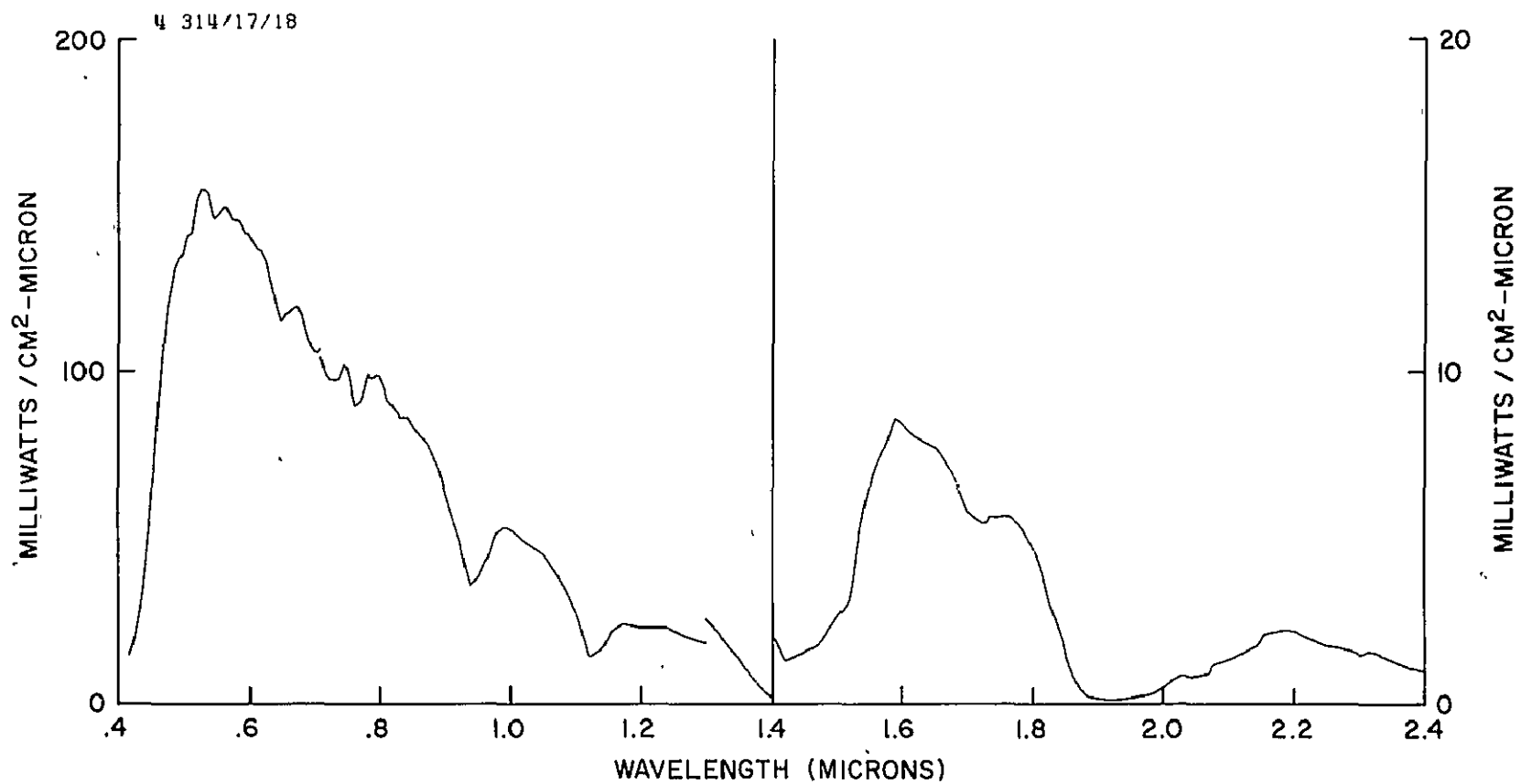
The following spectra were taken on November 10, 1969 (Julian Day 314) from the NASA C47 aircraft of Lewis Research Center. The C47 was piloted by Byron Batthauer and Earl Boyer and crewed by George Ford all of Lewis Research Center. The aircraft was just south of Toledo, Ohio on a transit flight from Cleveland, Ohio to Denver, Colorado. The C47 was at an altitude of 8000 ft. (2.44 km) and the cloud top was at approximately 6000 ft. (1.83 km).

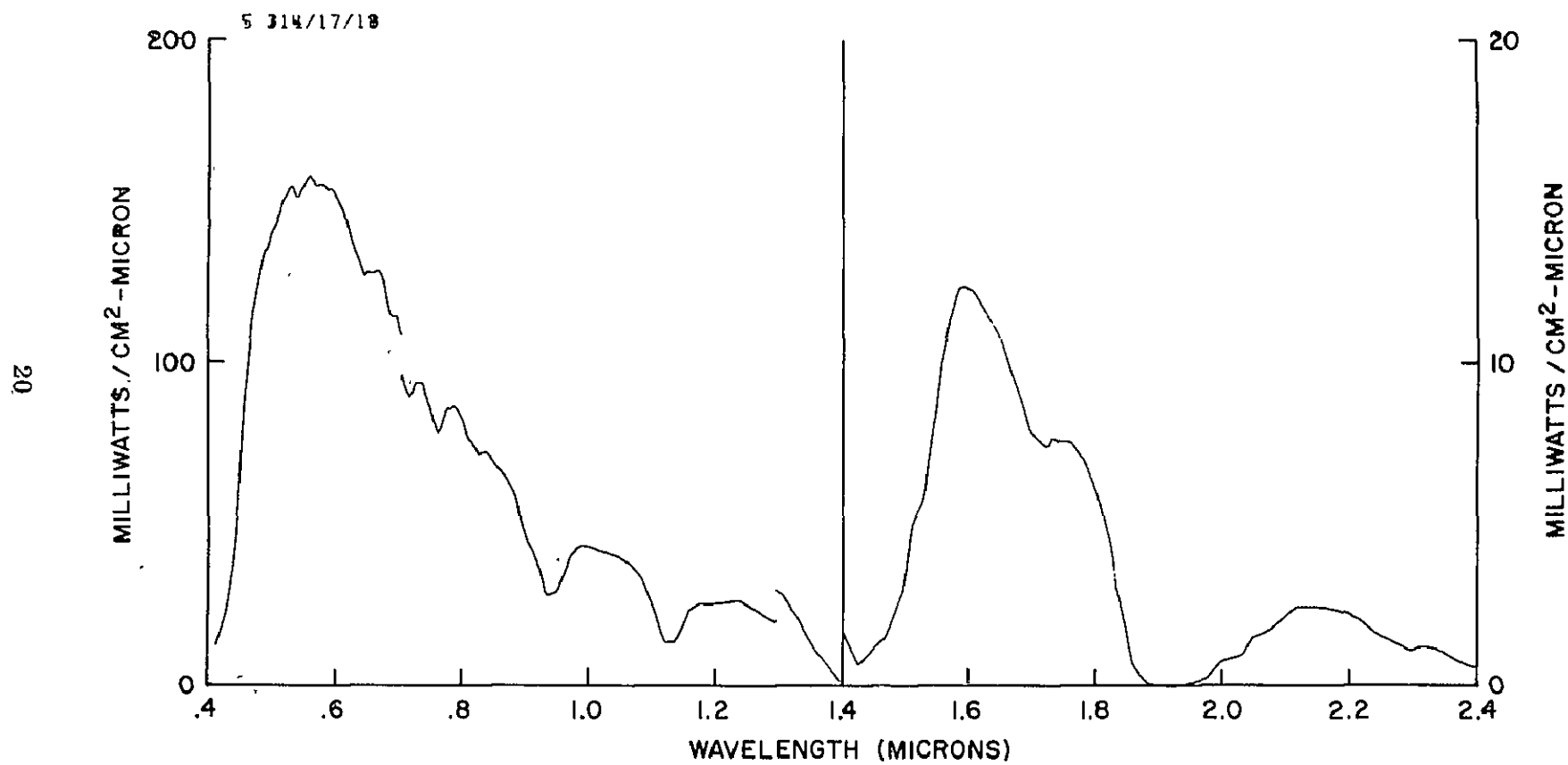
The cloud was thick with clear skies above and the spectra were taken between 17 hrs. 18 mins. and 17 hrs. 24 mins. Universal Time.

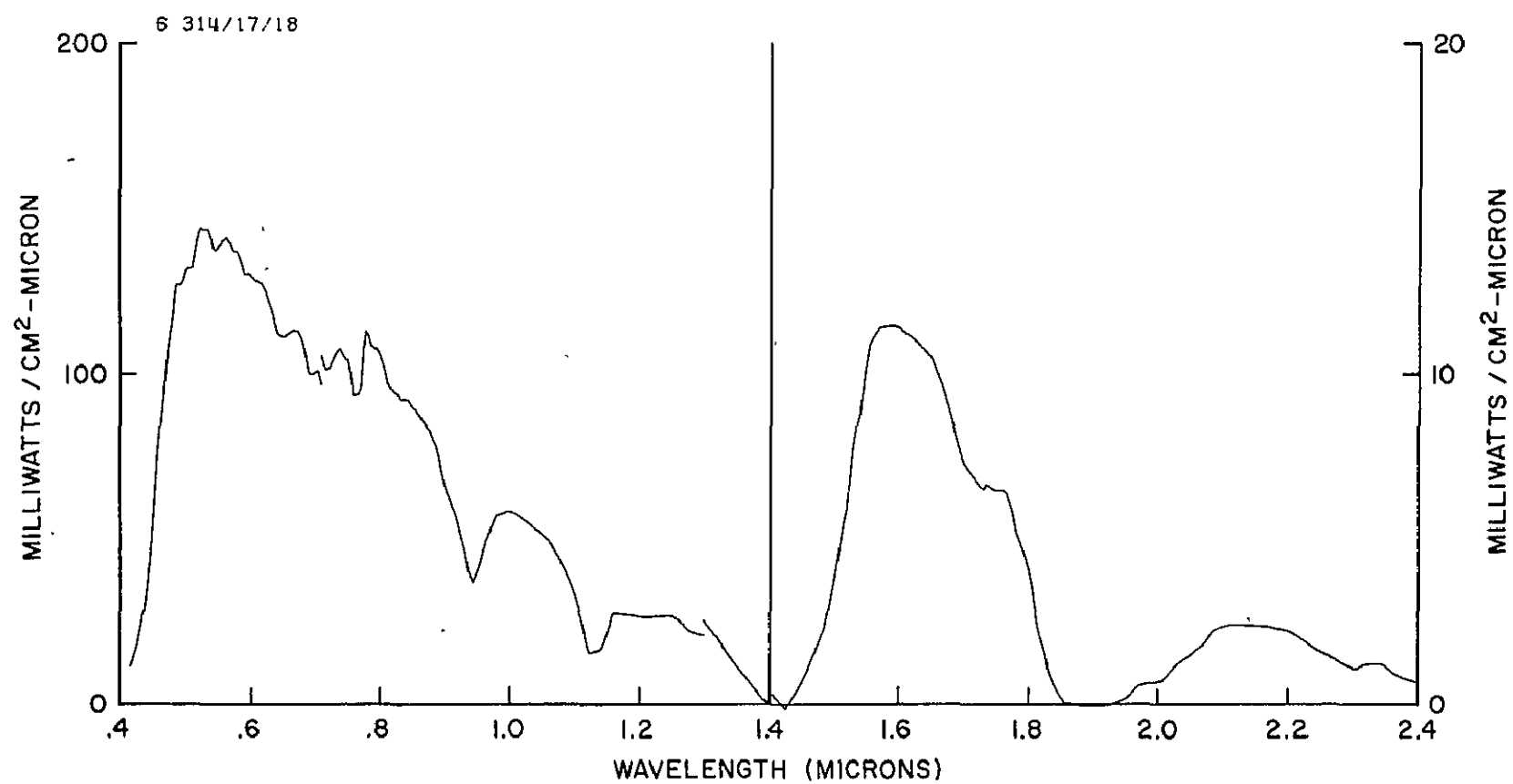




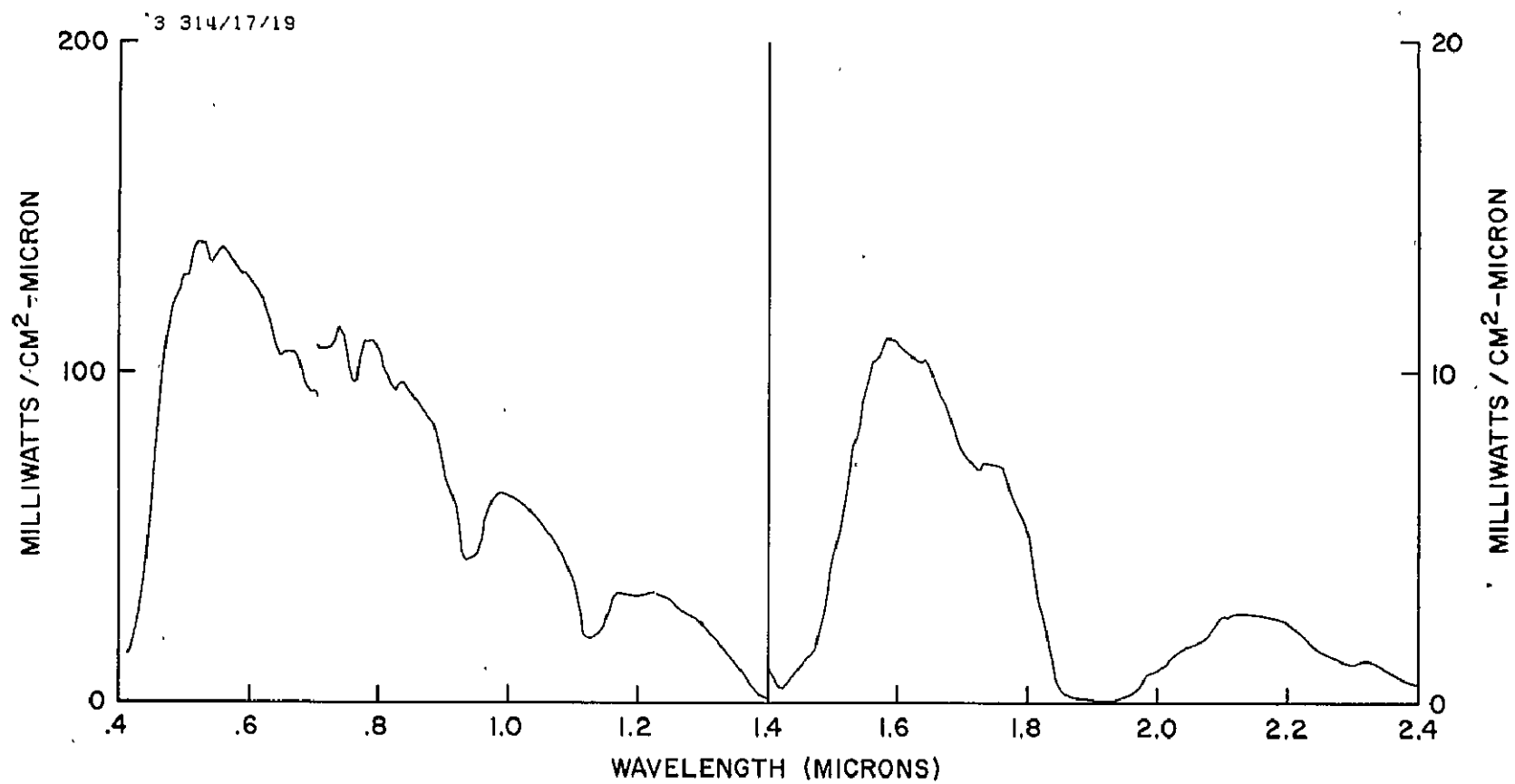


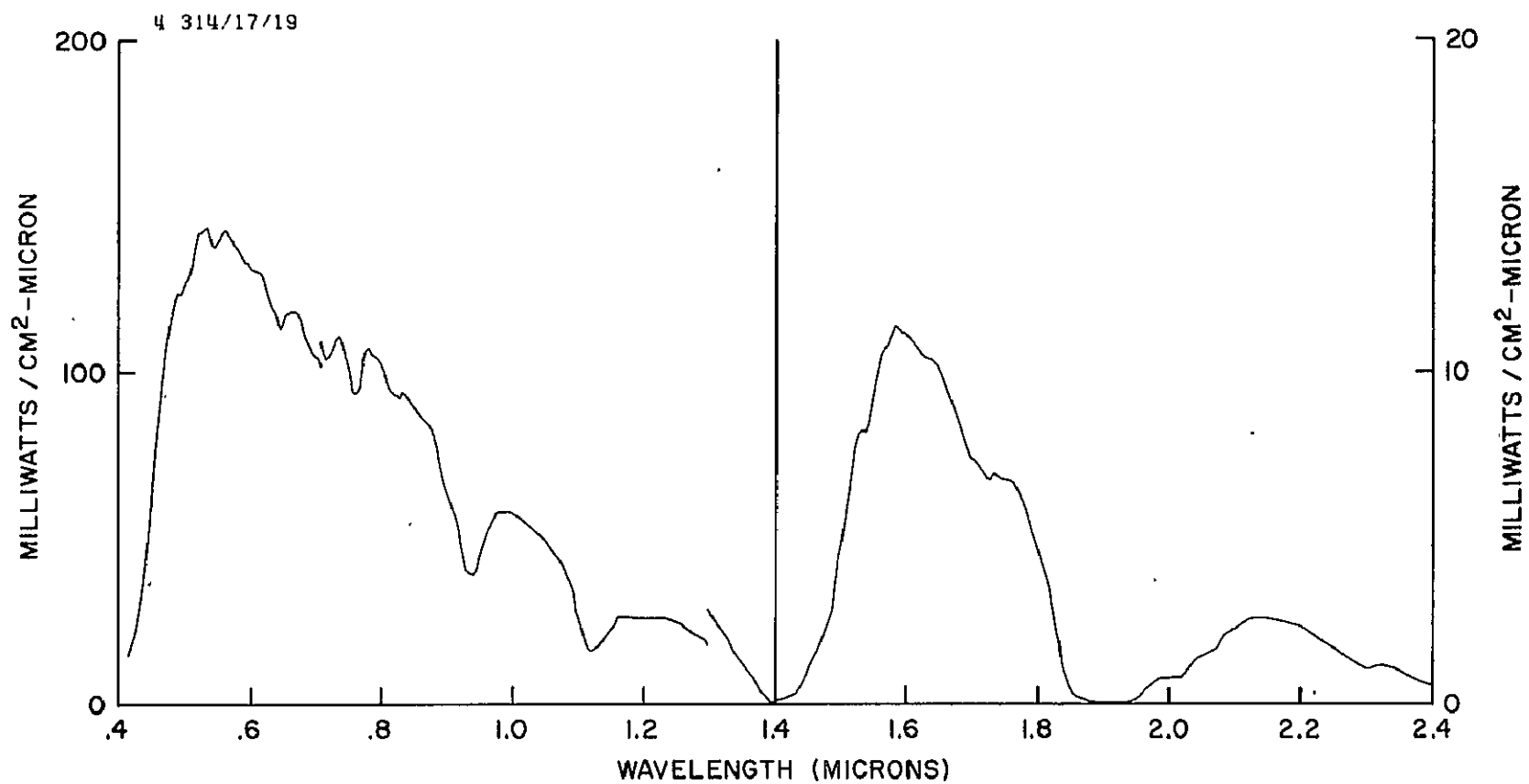


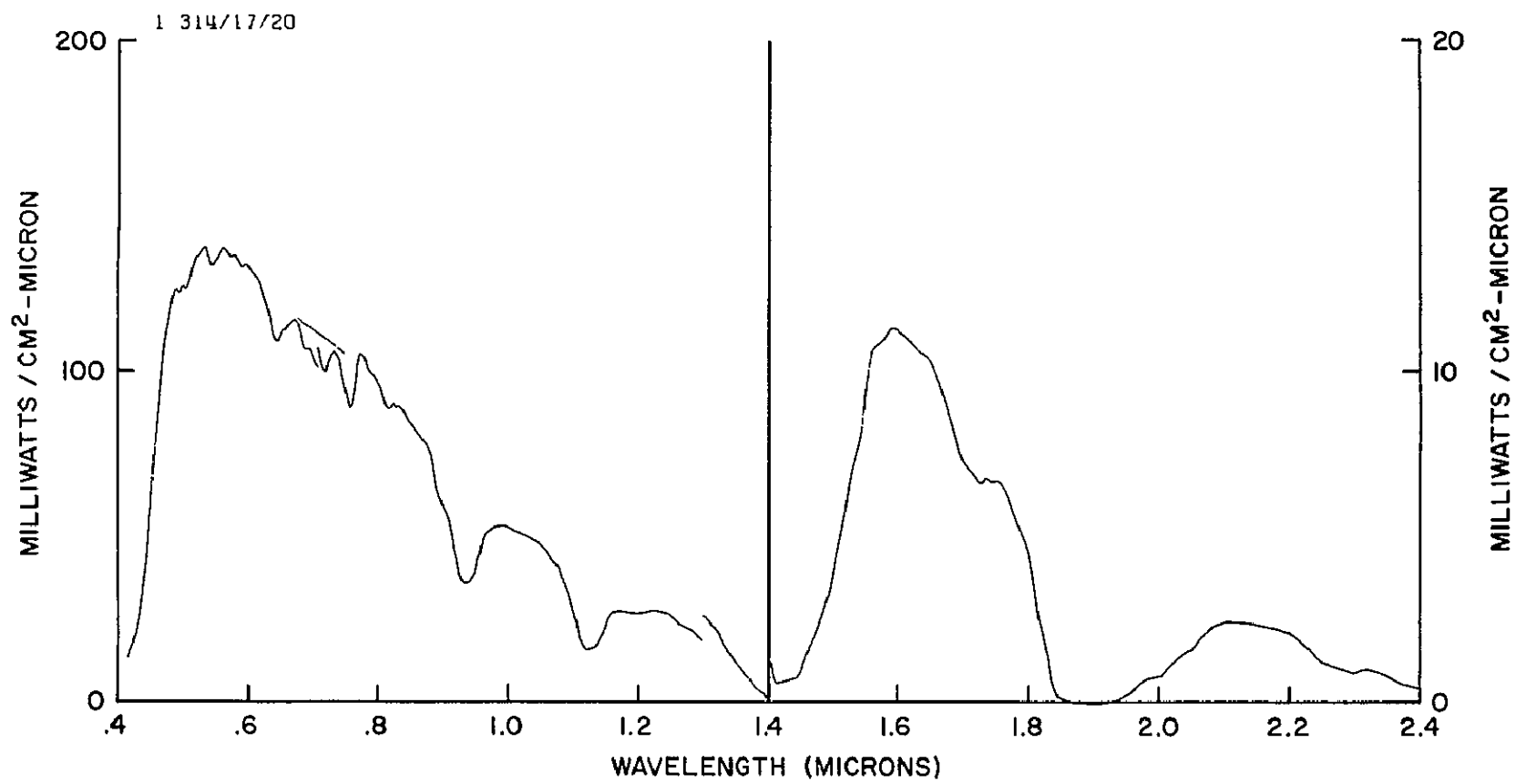


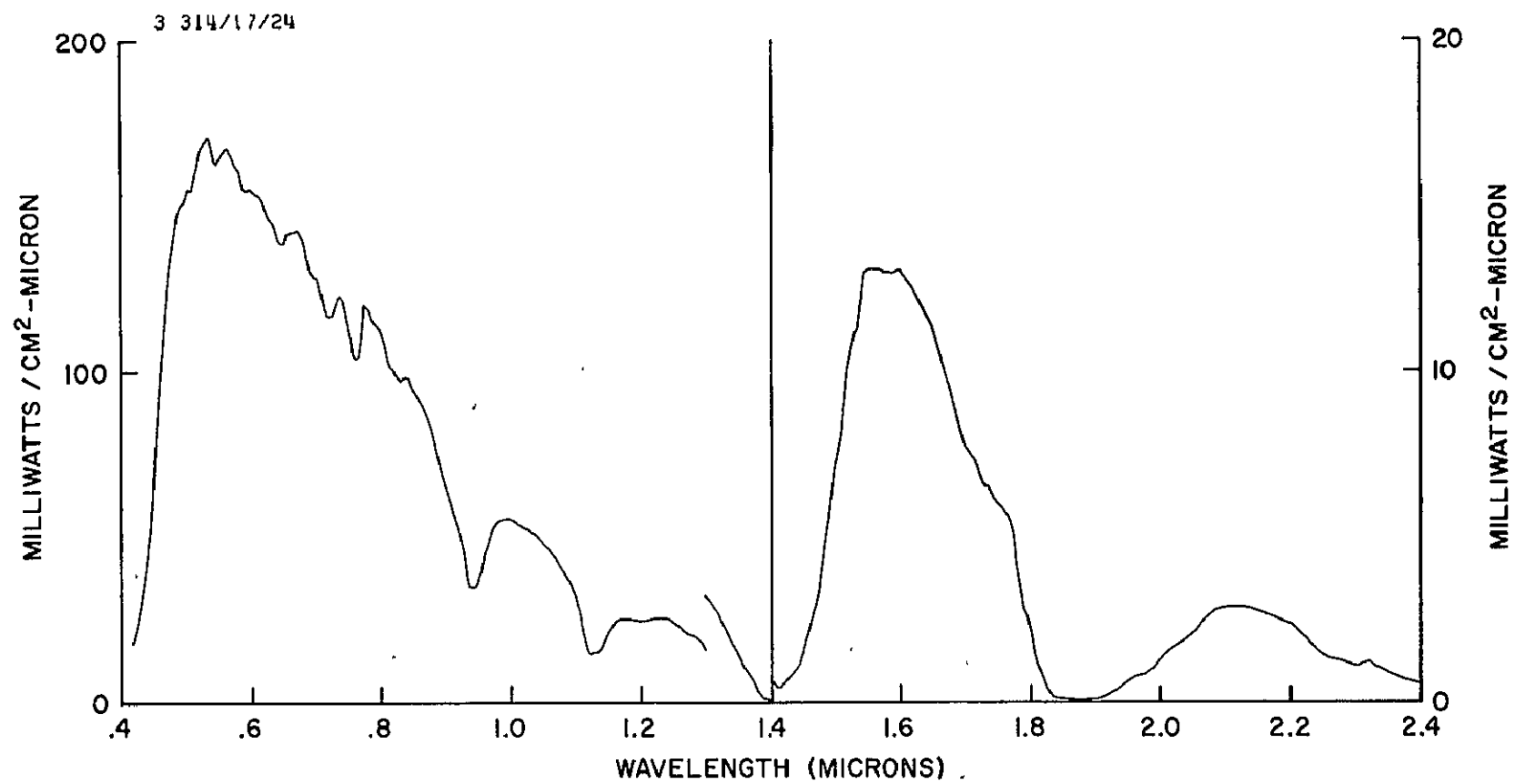






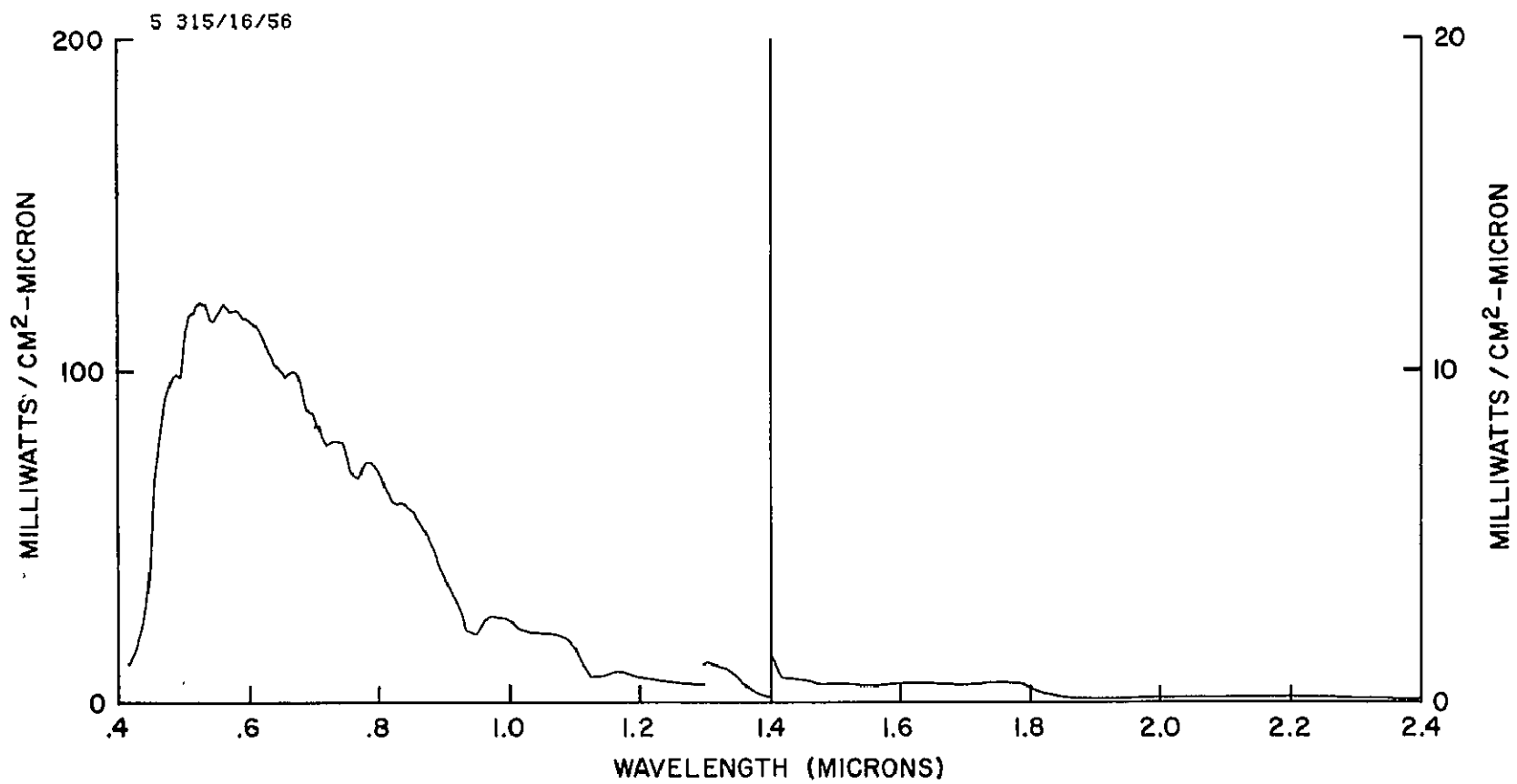


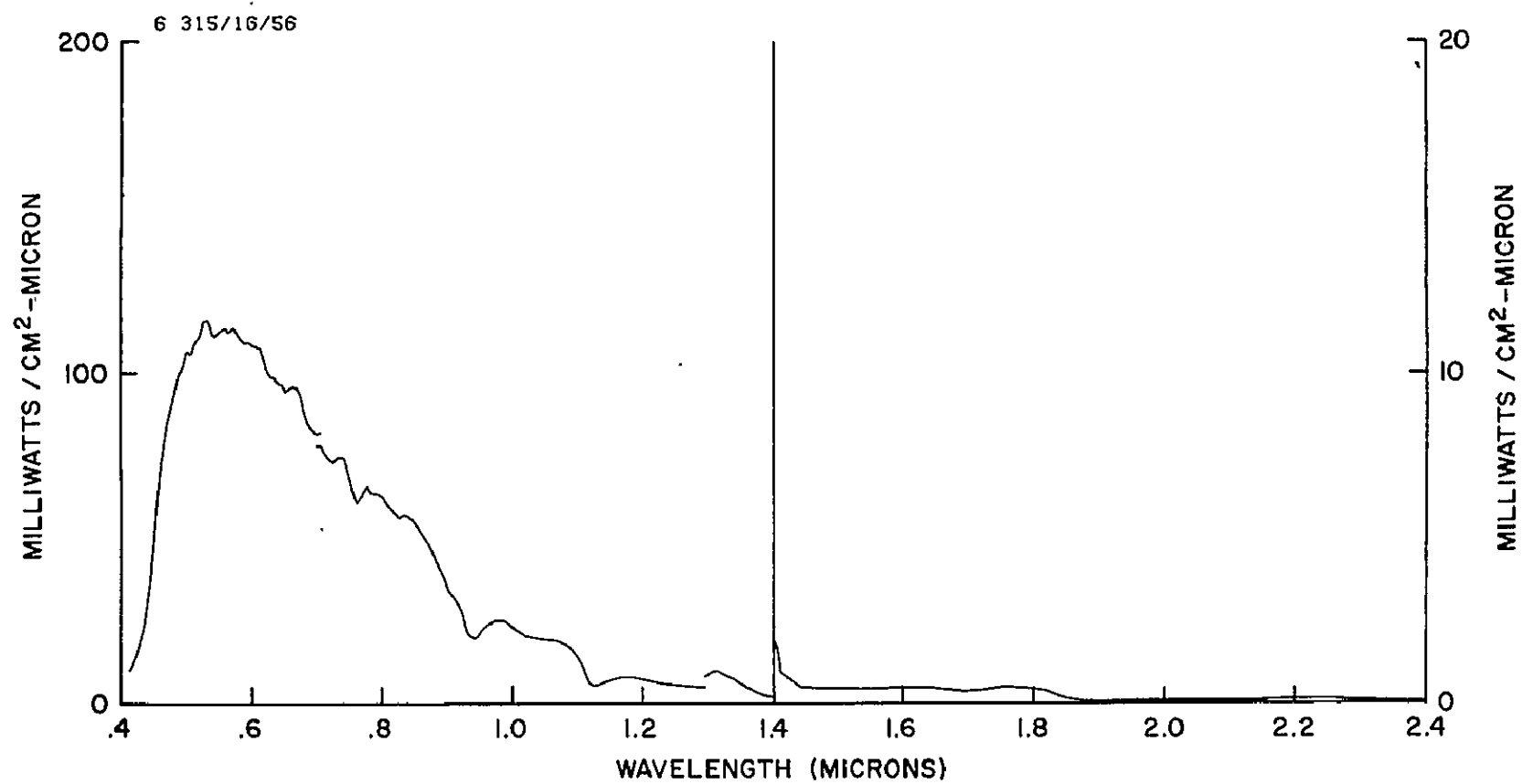


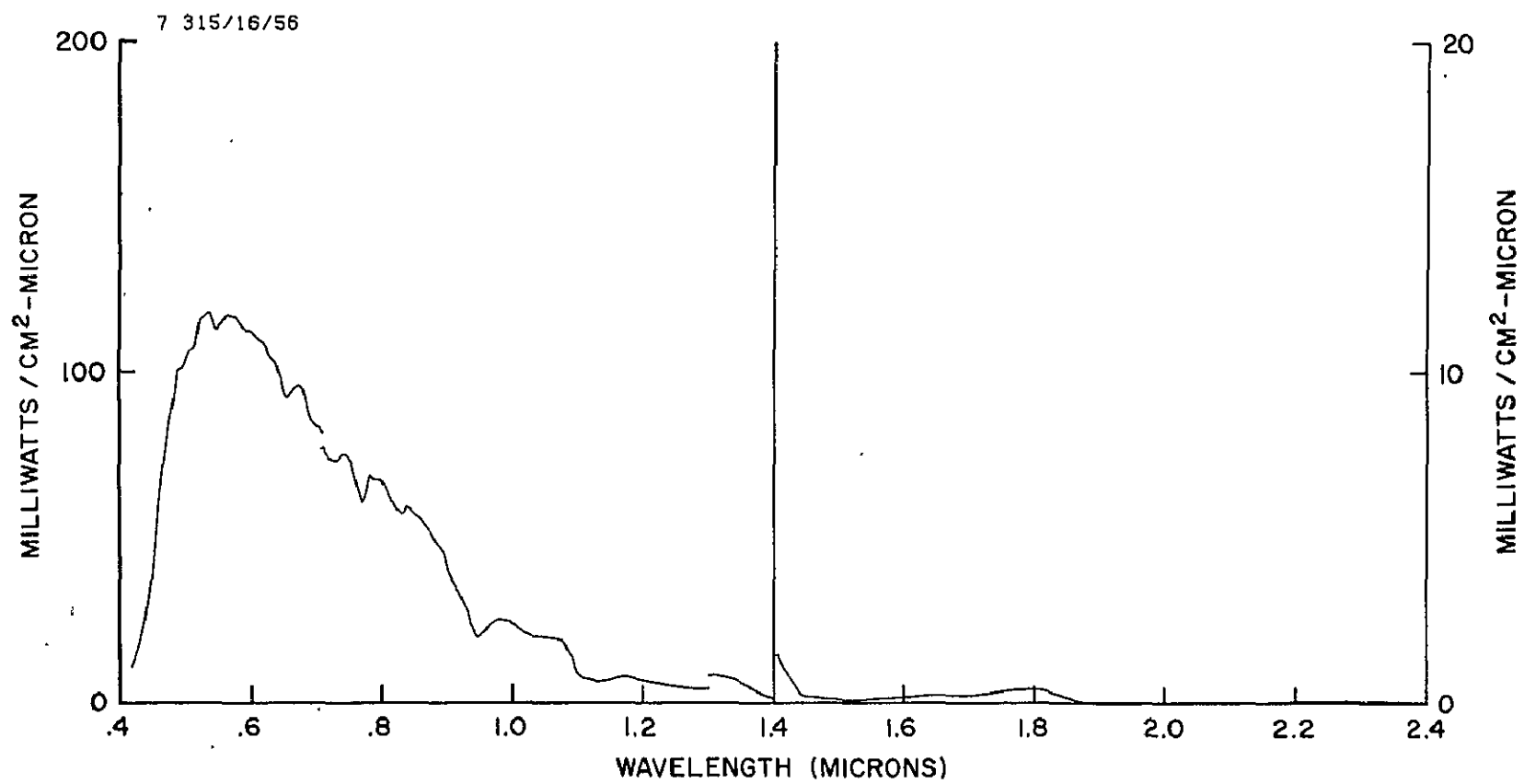


#### IV. SNOW COVERED VALLEY

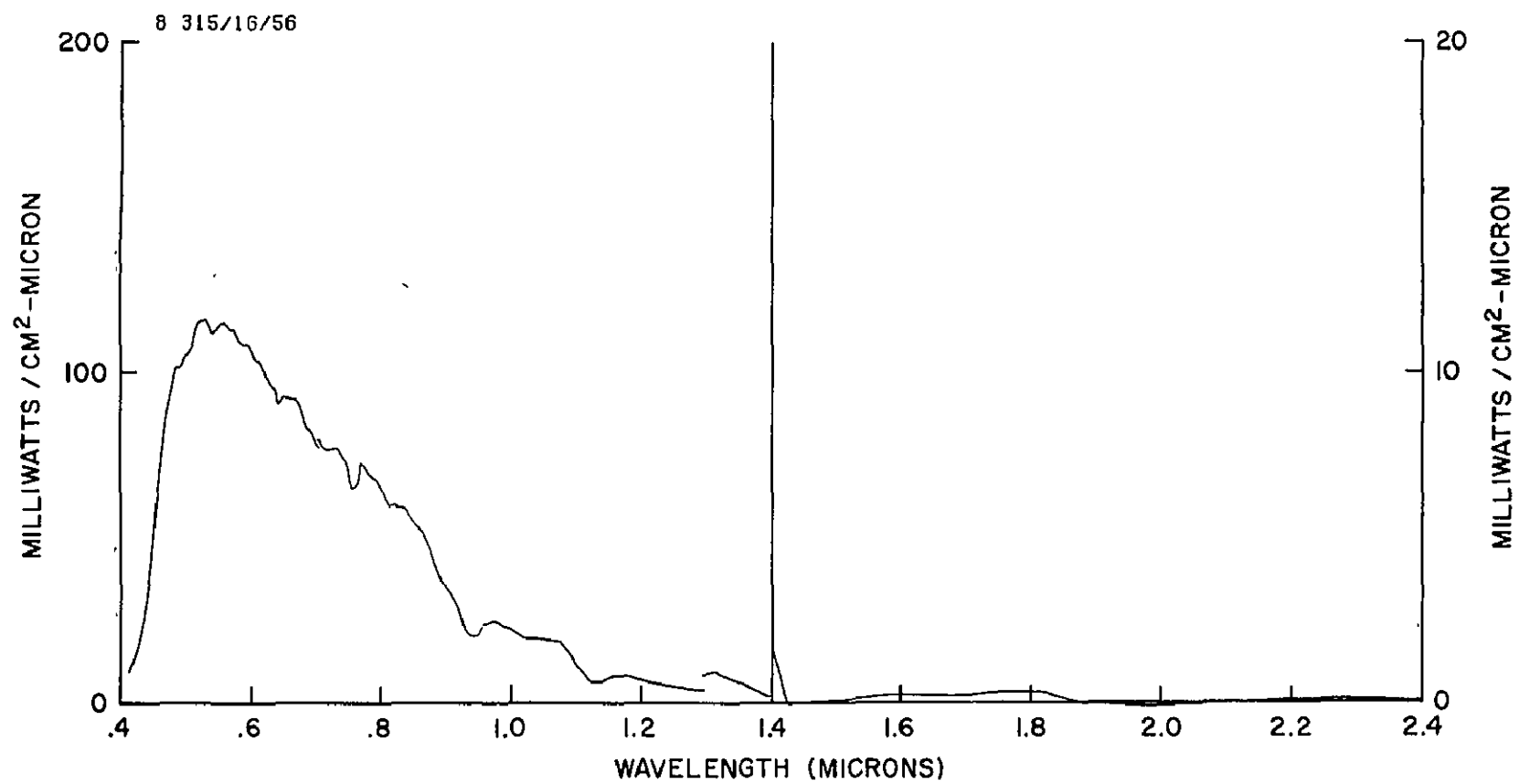
The following spectra were taken from the C47 aircraft on November 11, 1969 (Julian Day 315) over a snow covered valley floor north of Cheesman Lake, Colorado. Aircraft altitude was 7400 ft. (2.26 km) with a 1000 ft. (0.3 km) ground clearance determined by a radar altimeter. The sky was clear and the snow was over a week old according to local reports. The spectra were all taken during a one minute interval at 16 hrs. 56 mins. Universal Time.







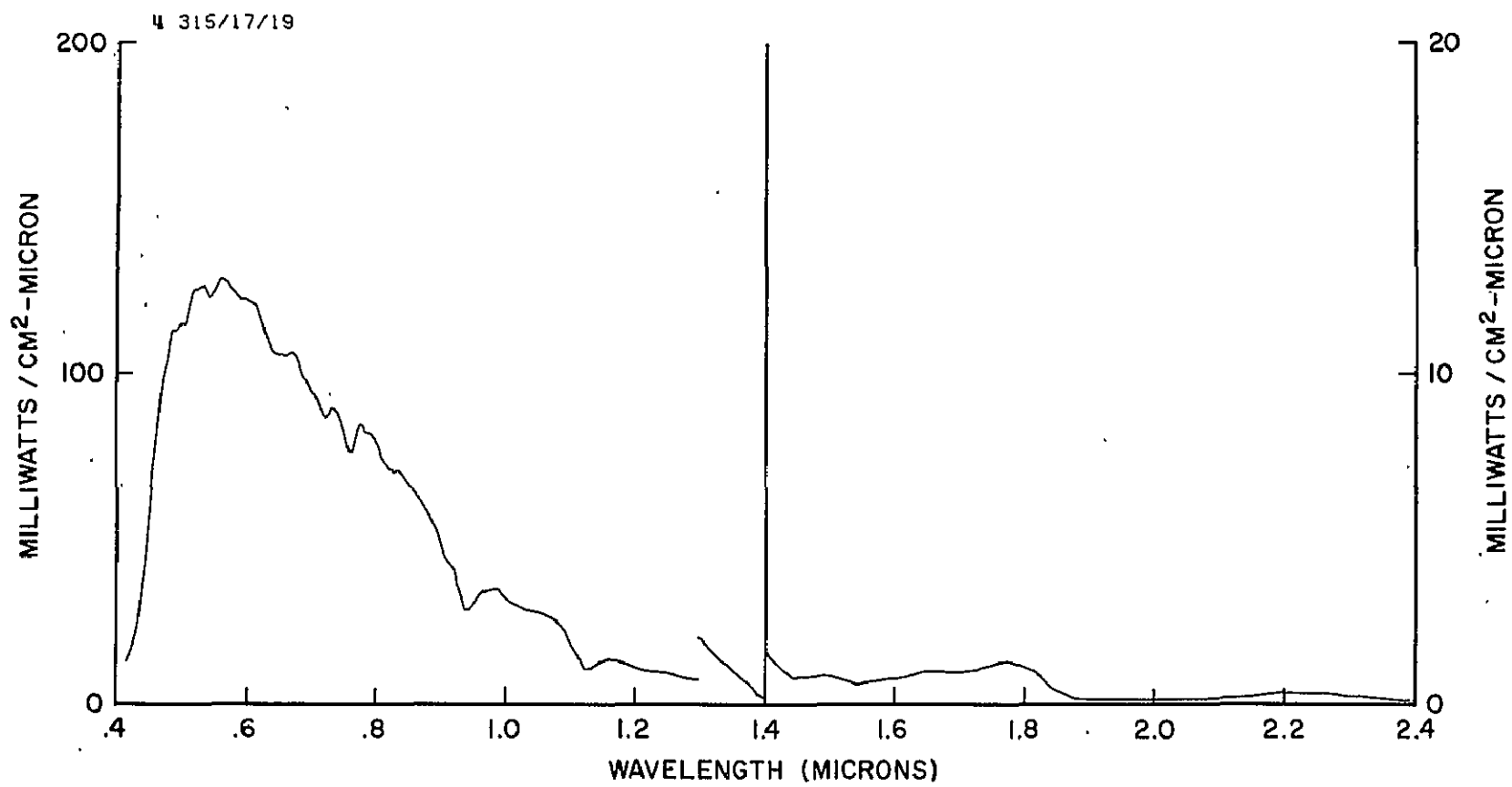


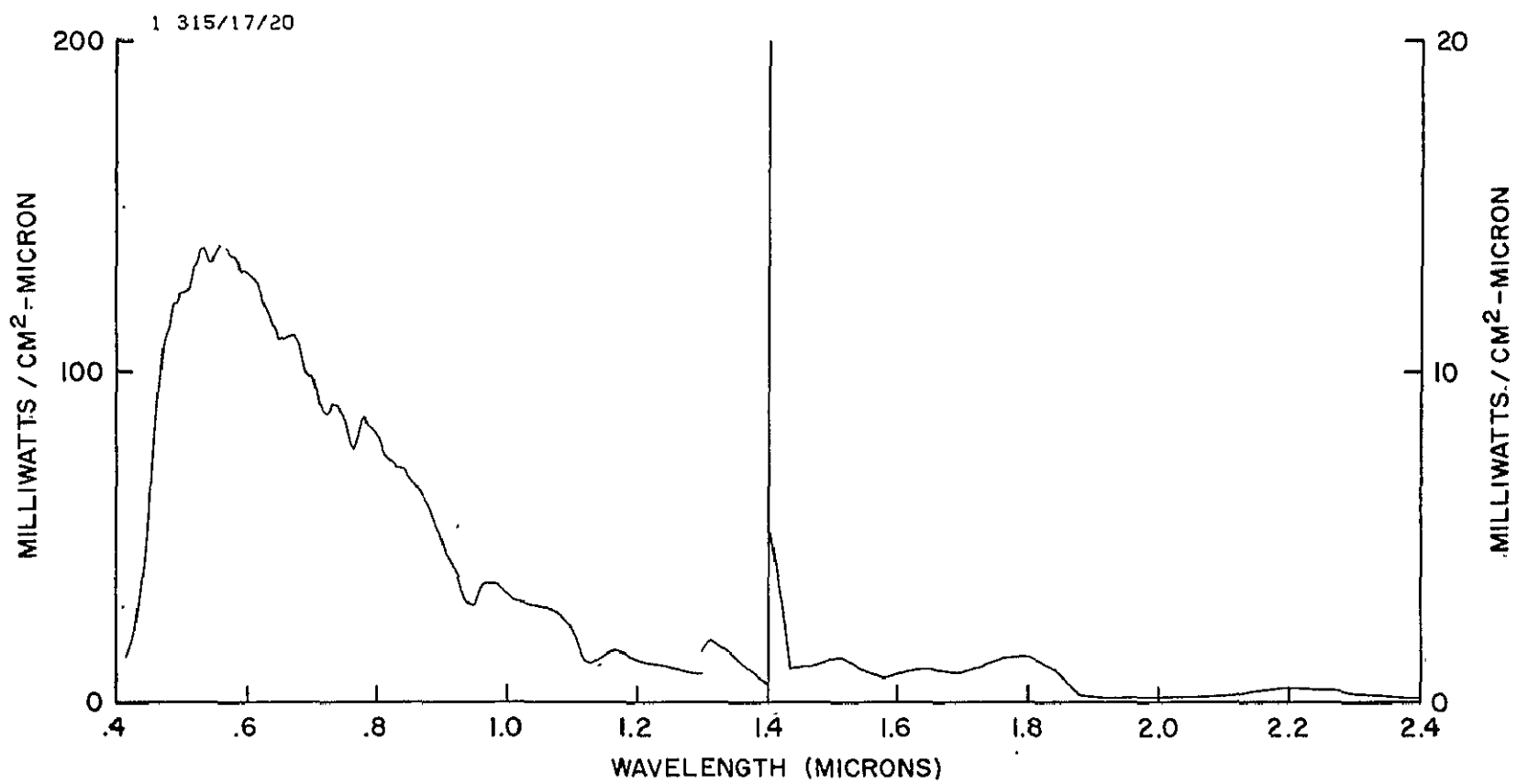


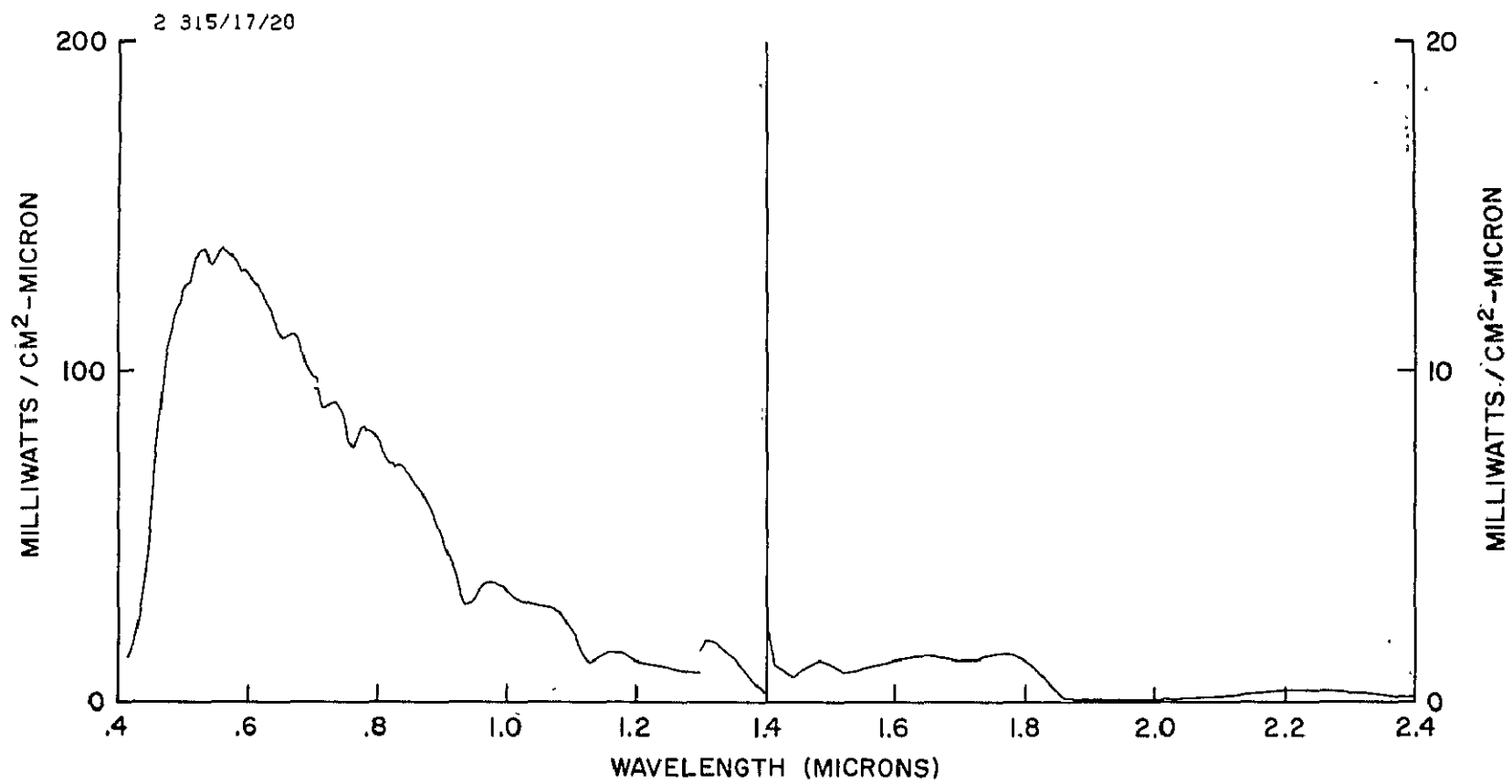
## V. SNOW COVERED LAKE

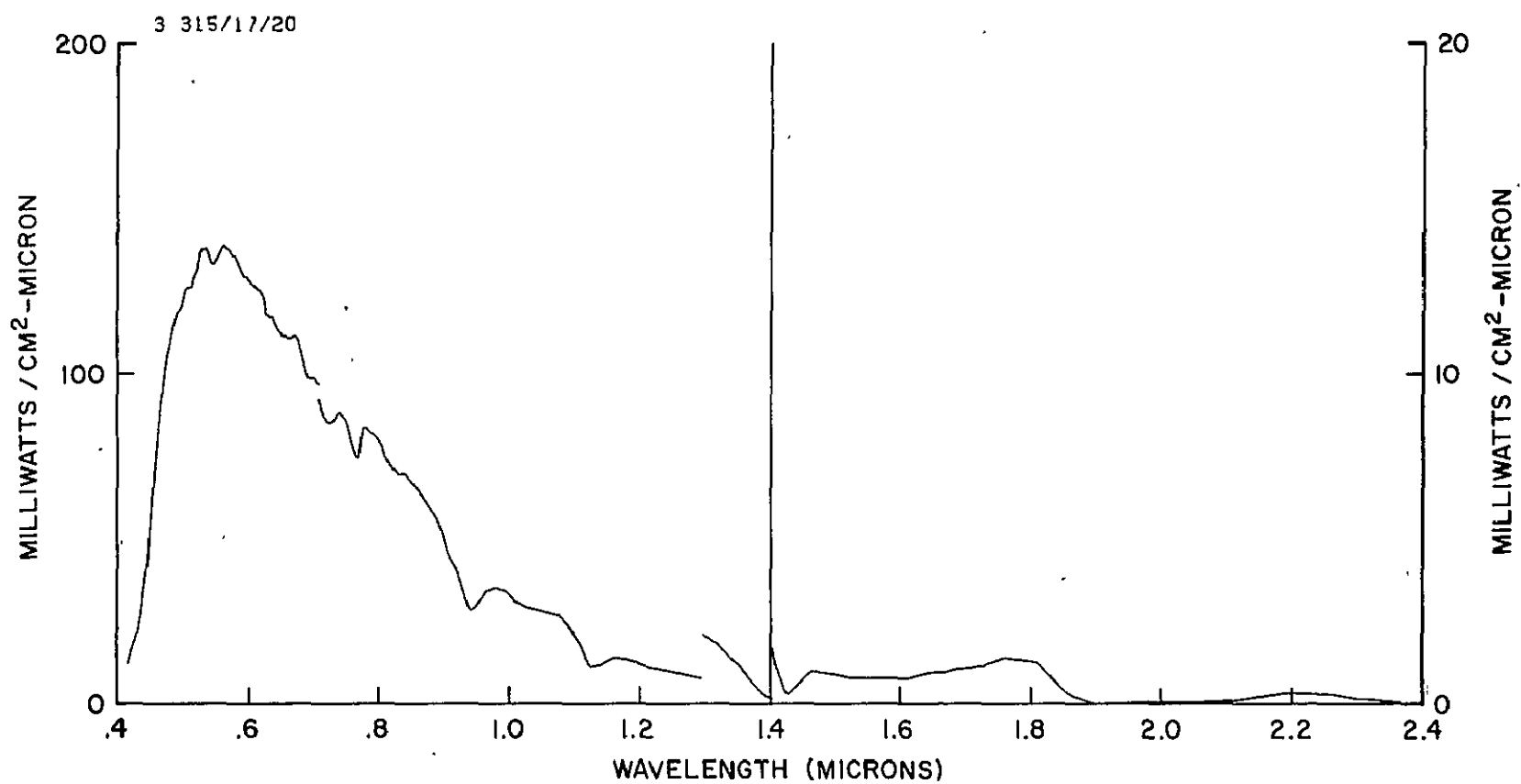
The following spectra were taken from the C47 aircraft on November 11, 1969 (Julian Day 315) over snow covered Cheesman Lake, Colorado. Cheesman Lake is about 34 miles from Denver on a 203° radial. At the time of the flight a 1000 ft. (0.3 km) ground clearance was maintained using the radar altimeter over the lake where surface is at an altitude of 6842 ft. (2.09 km). The lake was uniformly covered with snow of the same age as that seen in the valley of Section IV.

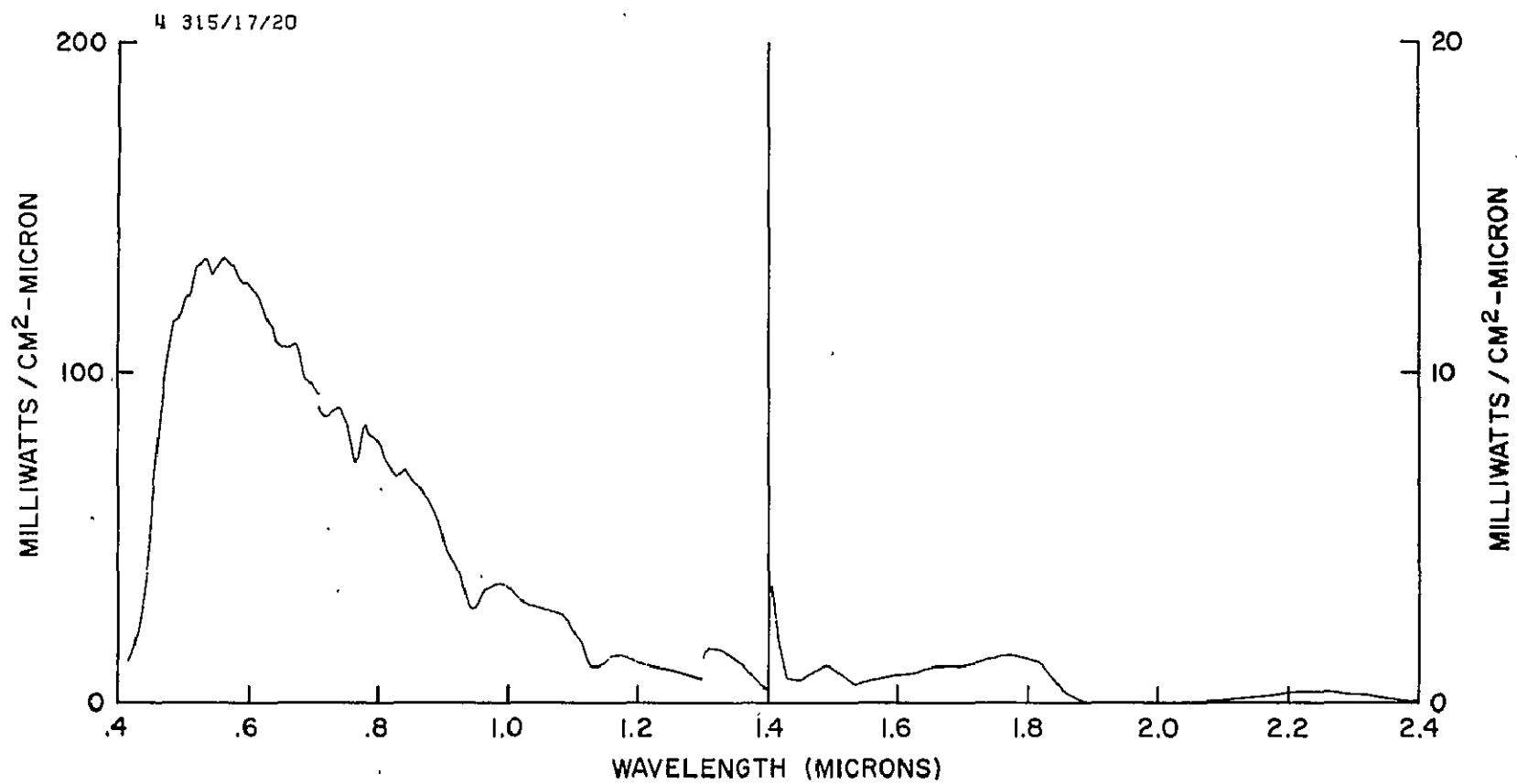
The sky was quite clear and the spectra were taken between 17 hrs. 19 mins. and 17 hrs. and 23 mins. Universal Time.

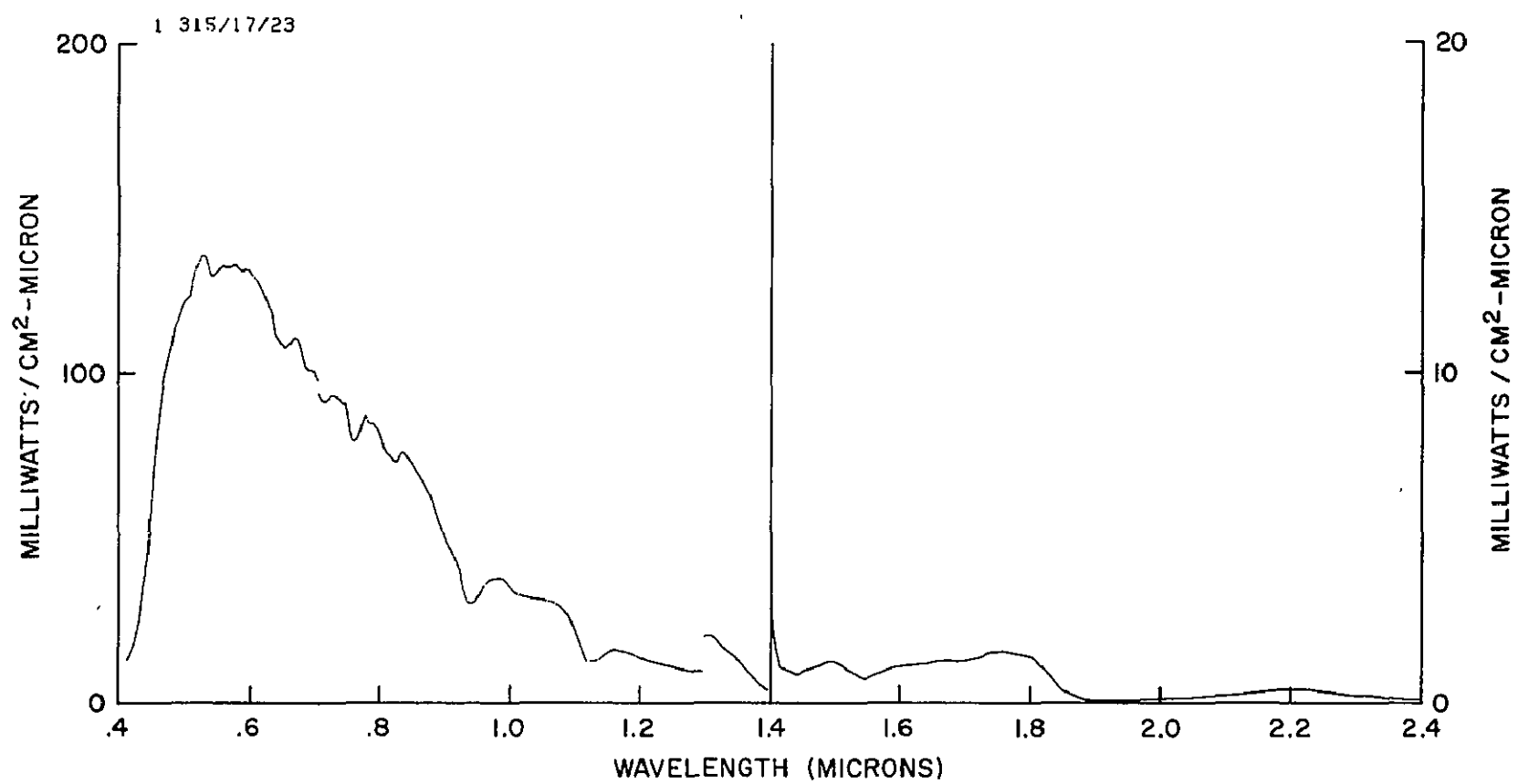




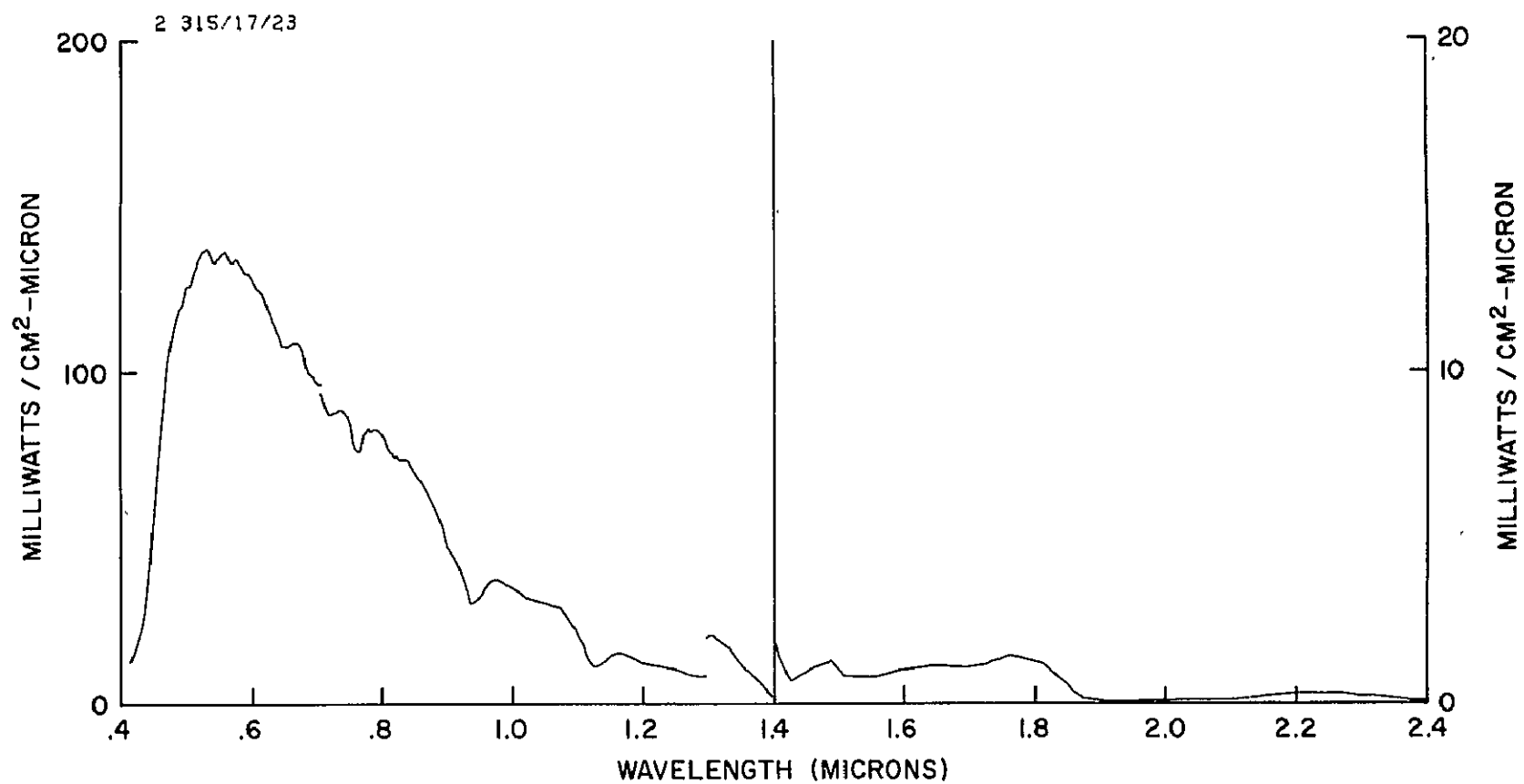


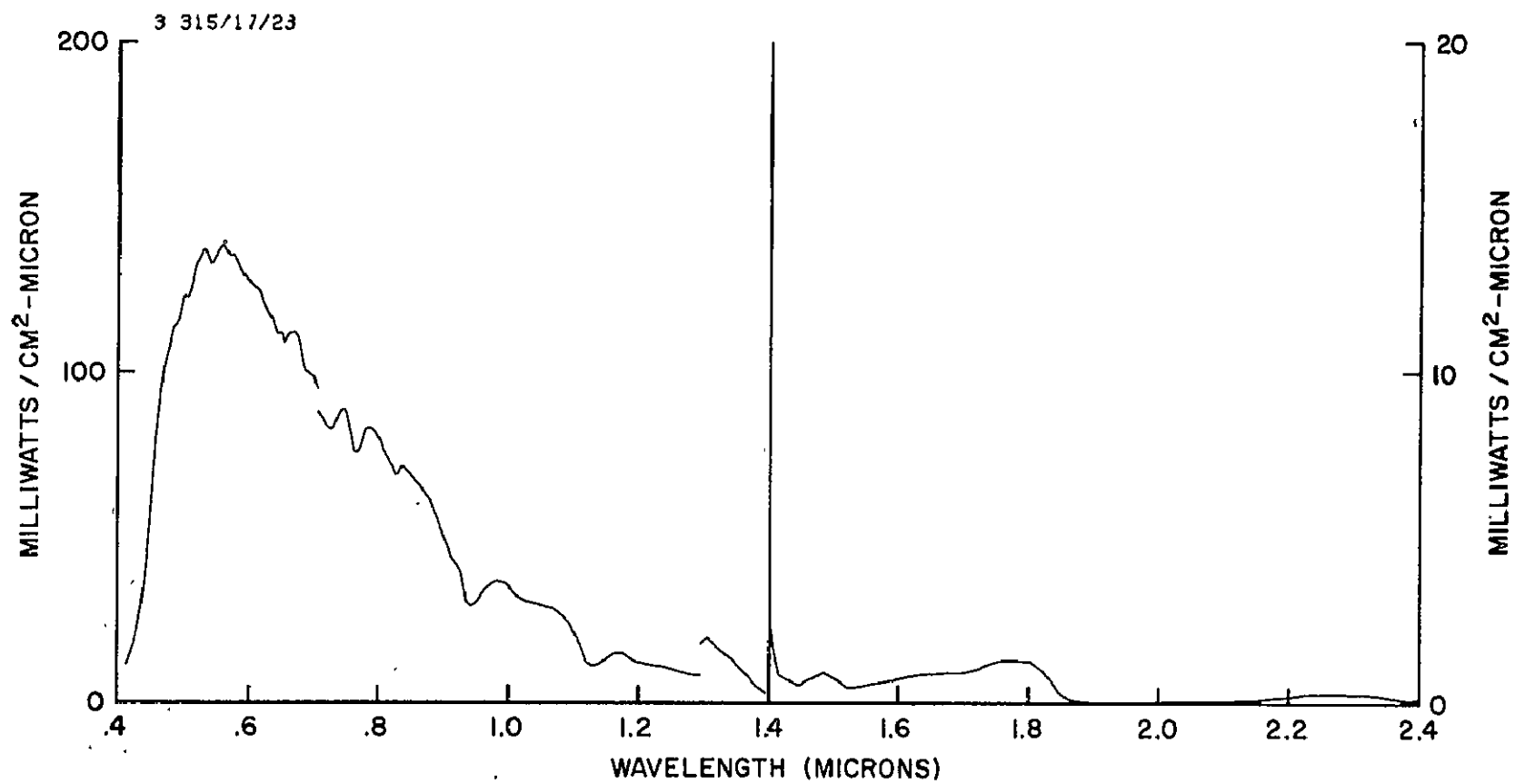


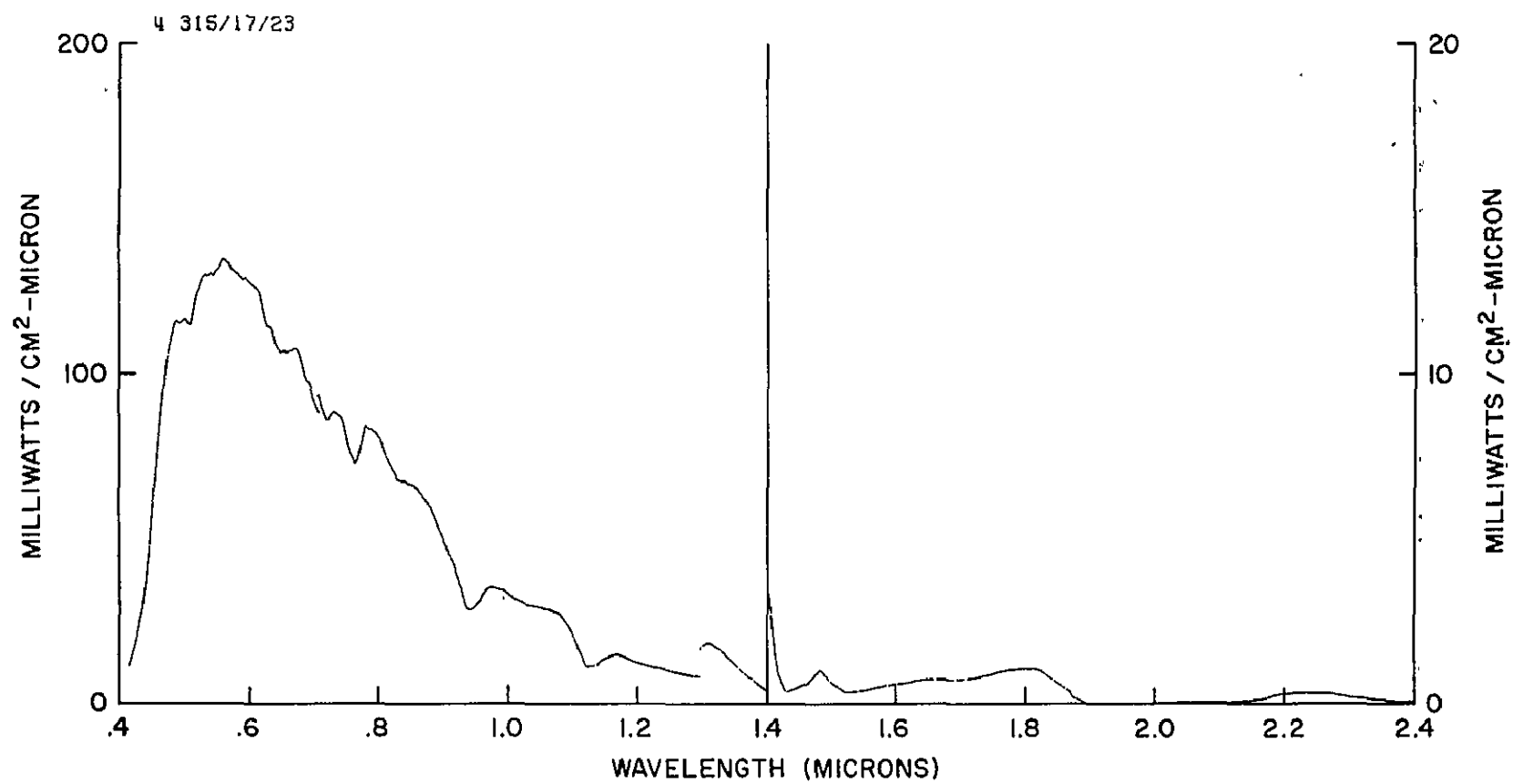


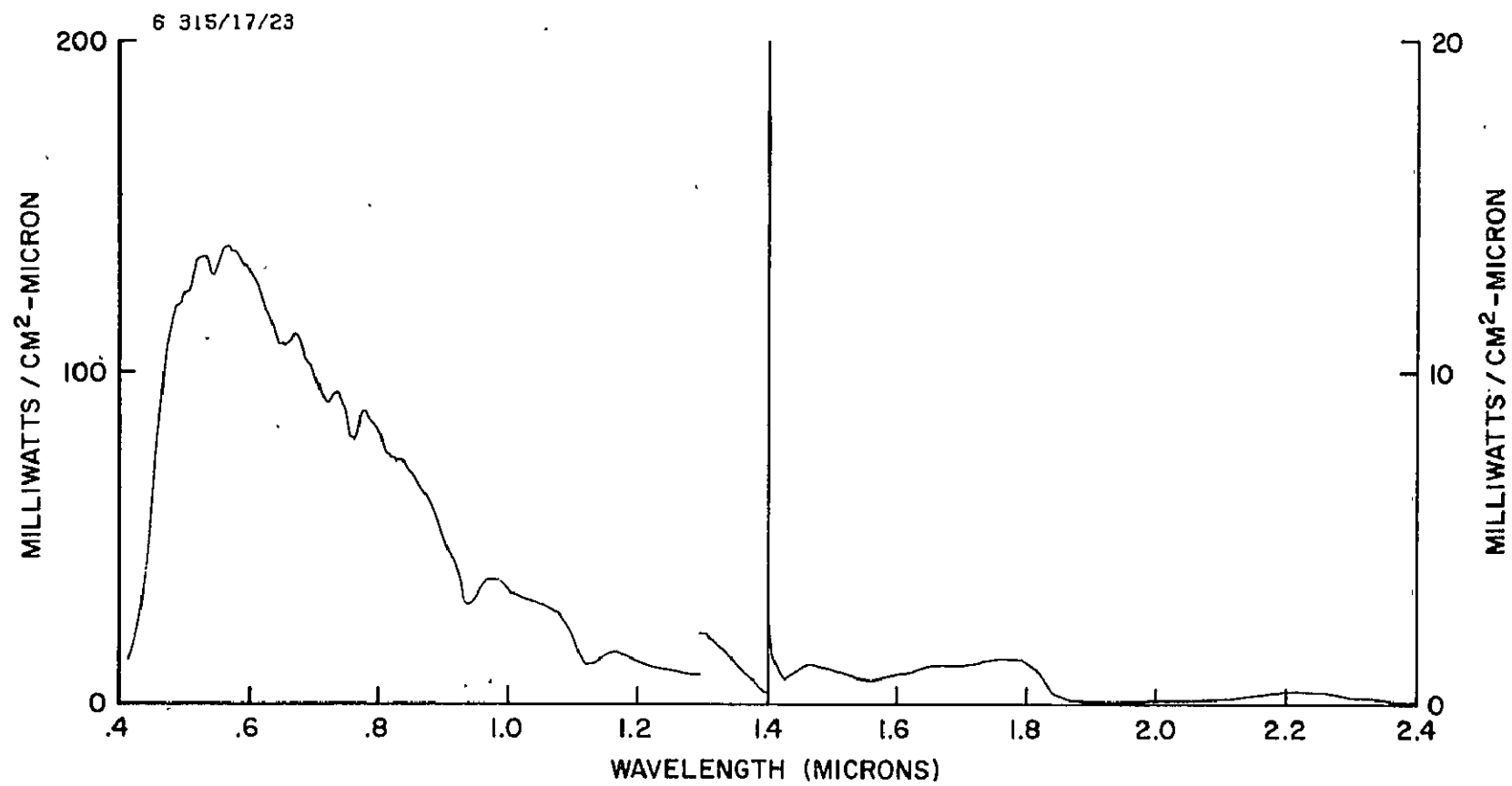


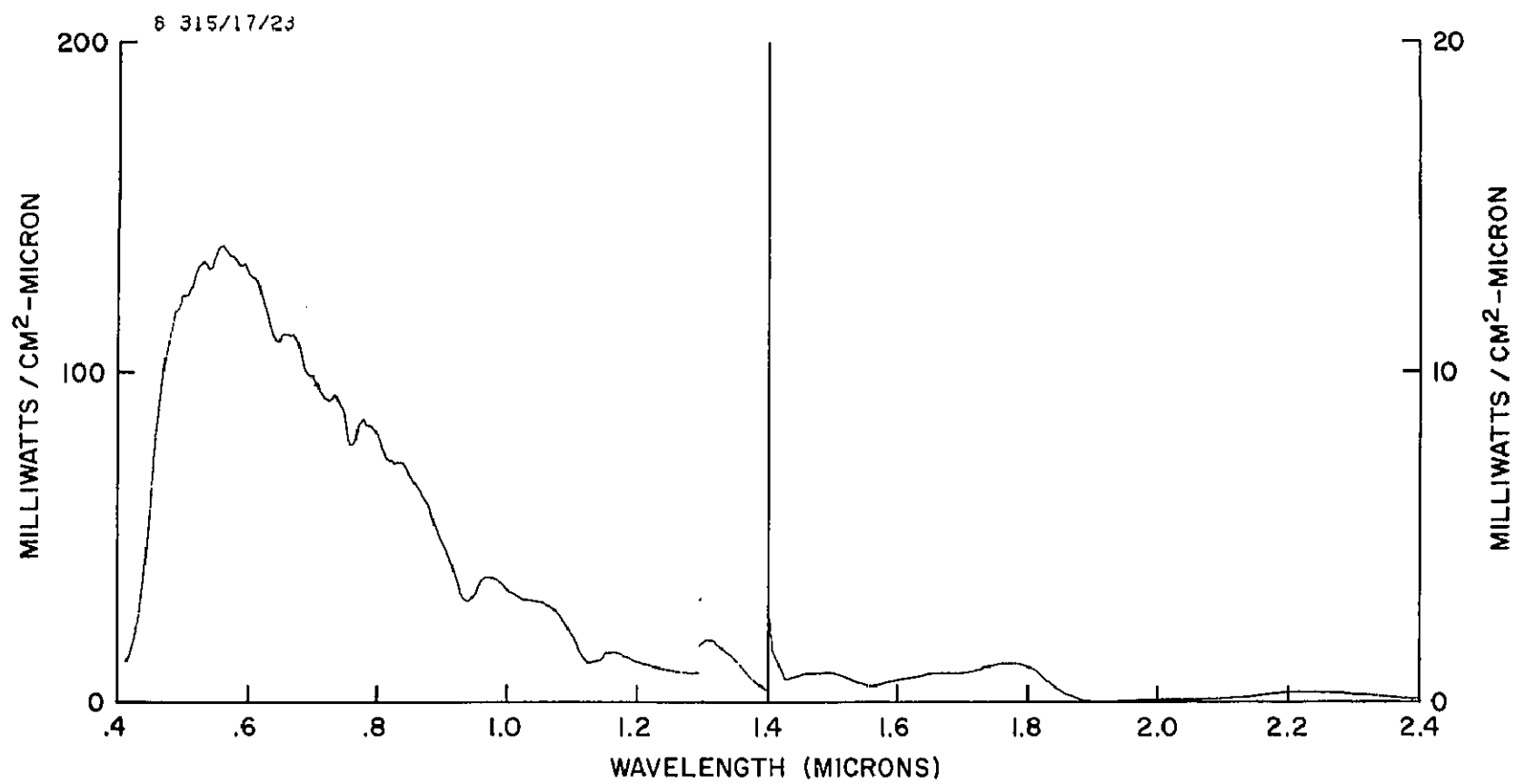






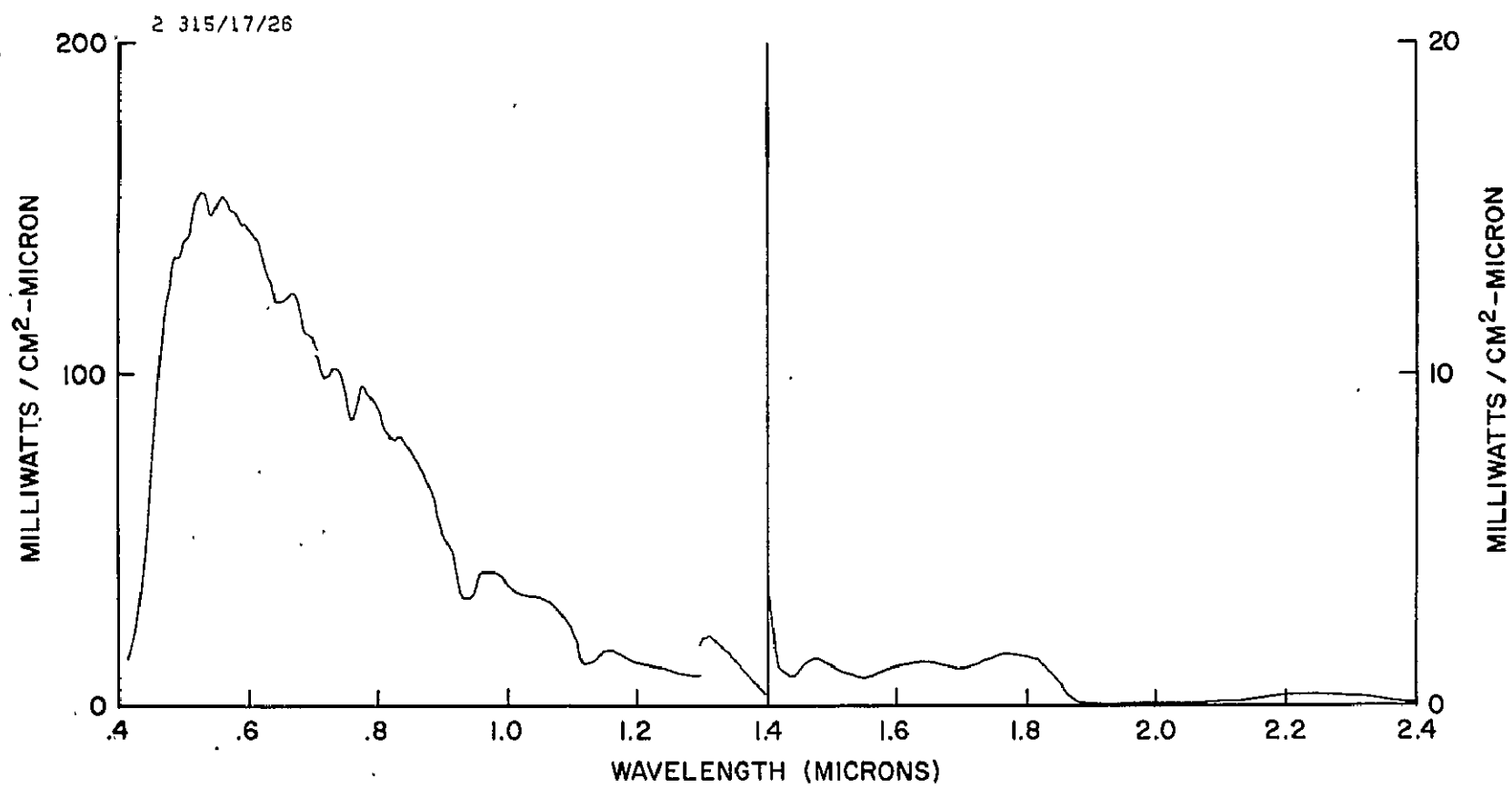


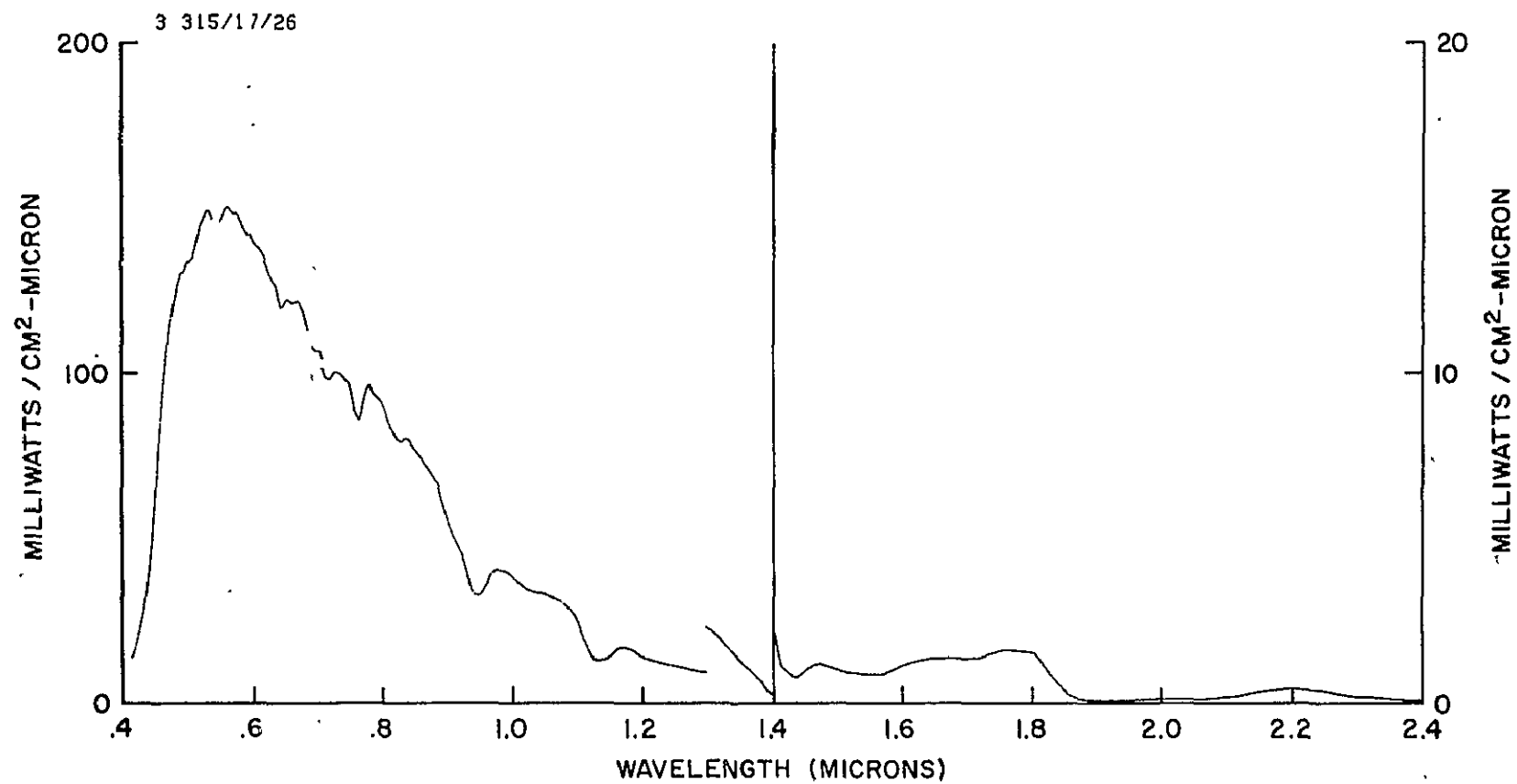




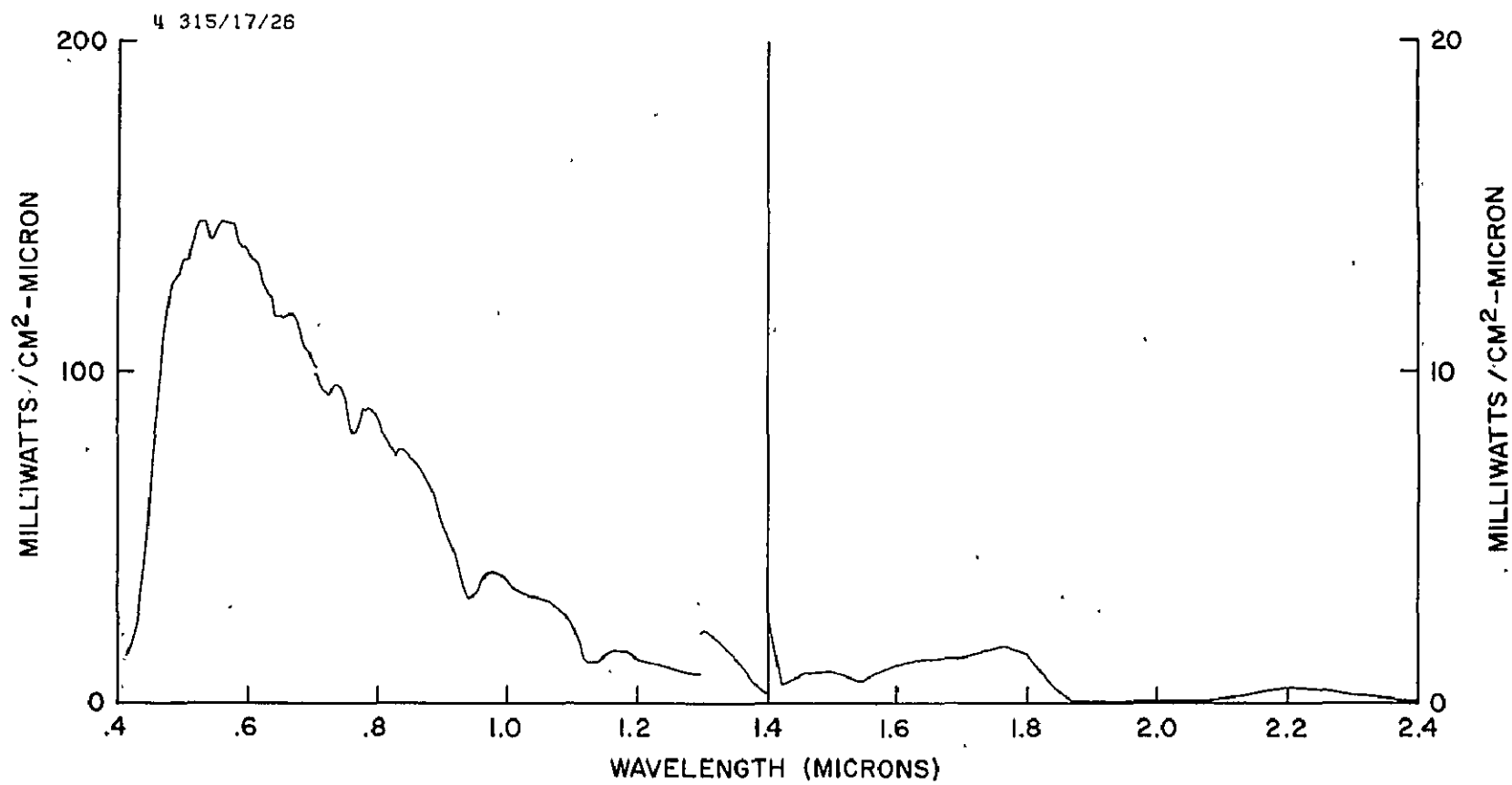
## VI. SNOW COVERED VALLEY AT CHESSMAN LAKE

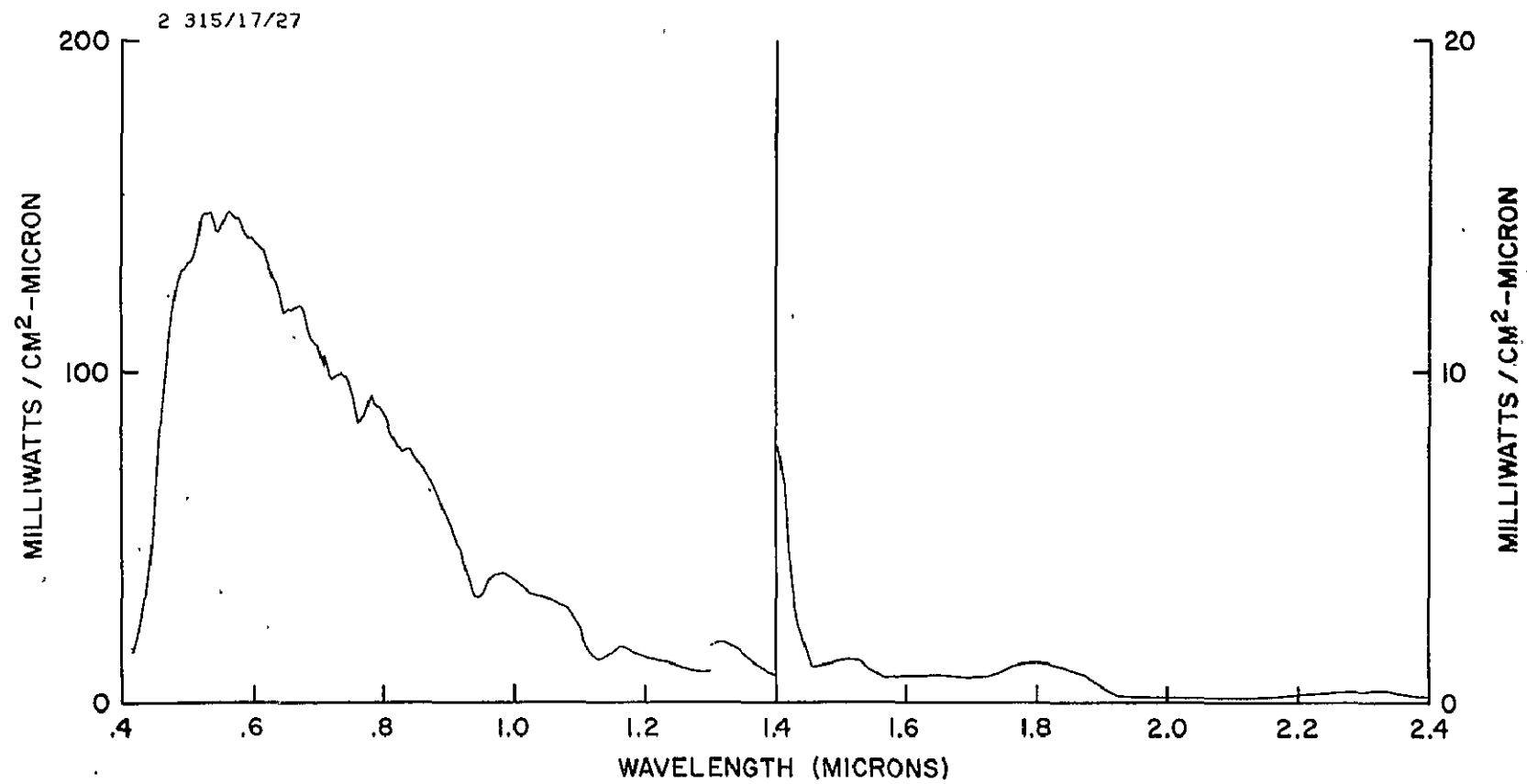
The spectra in this section were taken over snow in the valley immediately north of Cheesman Lake. All conditions except time were as described in Section V. The day was November 11, 1969 (Julian Day 315) and the spectra were taken between 17 hrs. 26 mins. and 17 hrs. 33 mins. Universal Time.

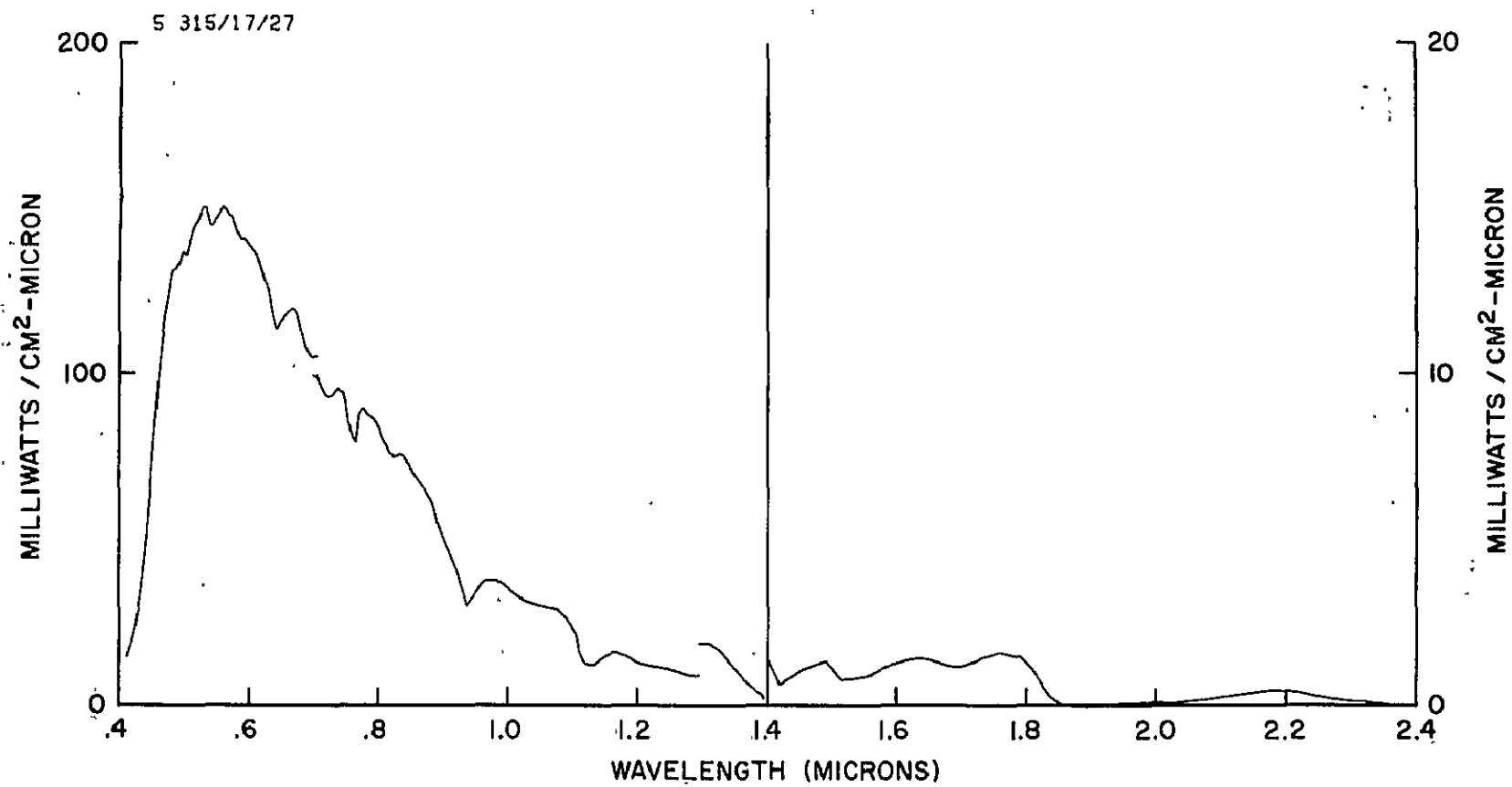


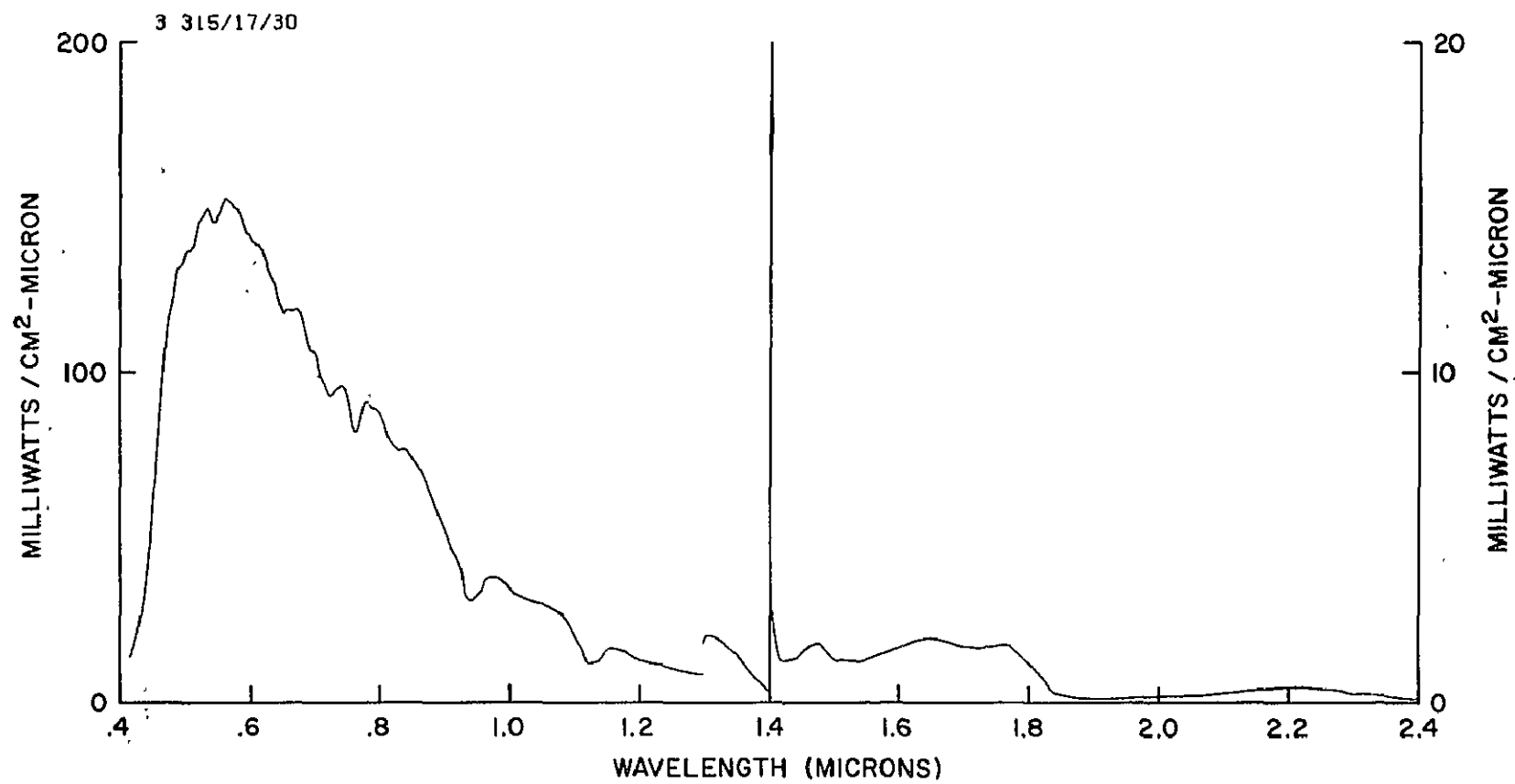


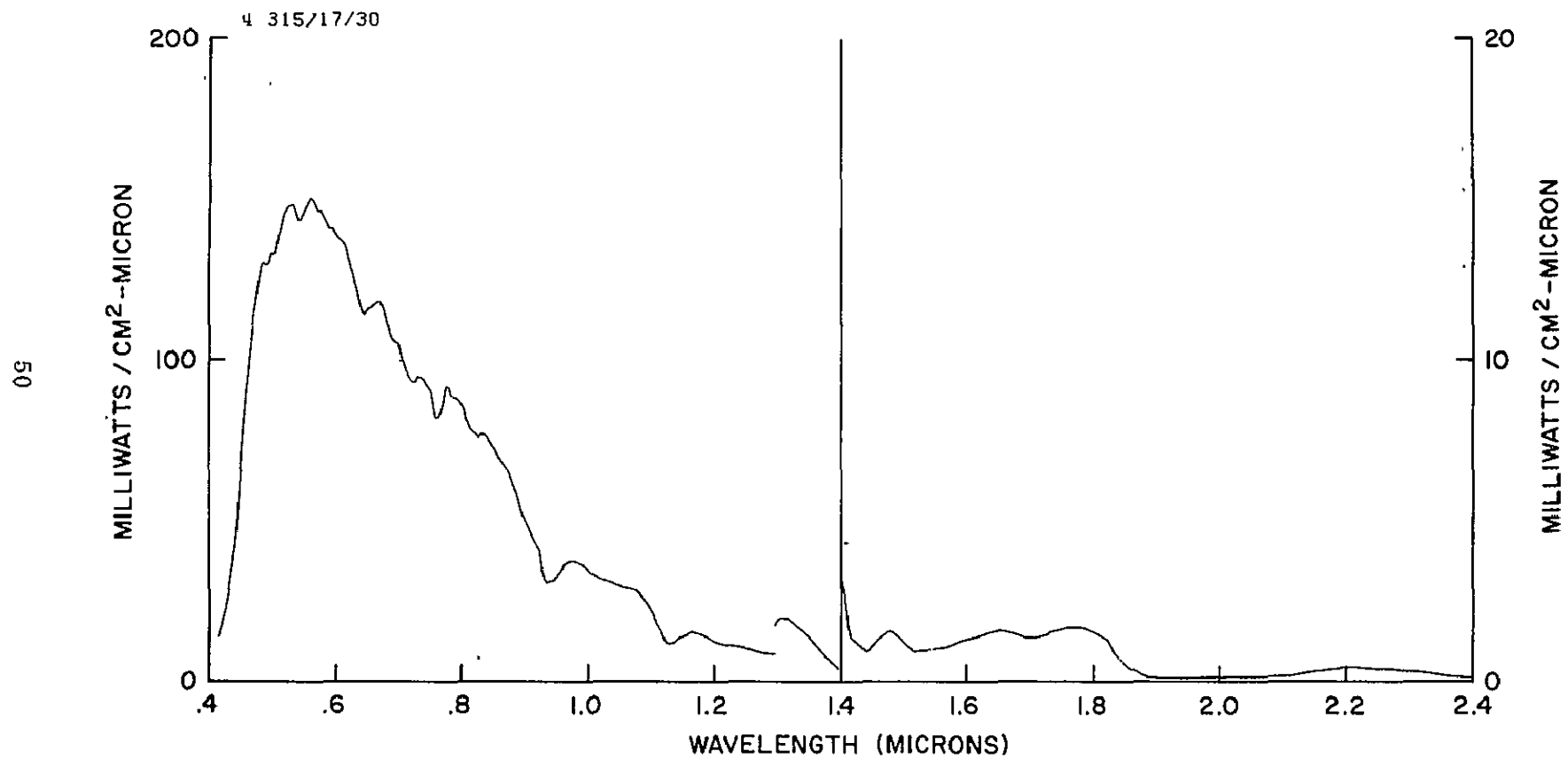


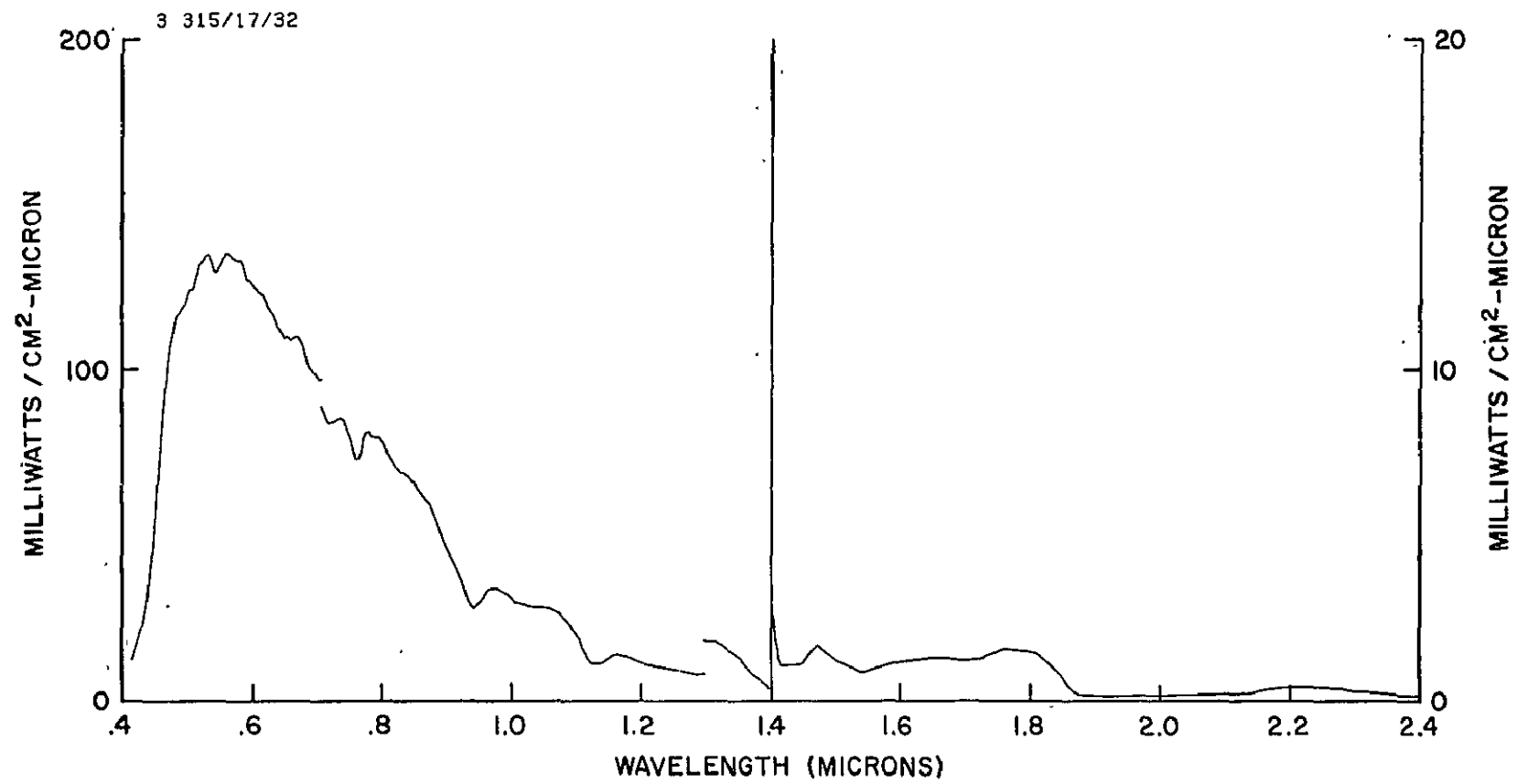


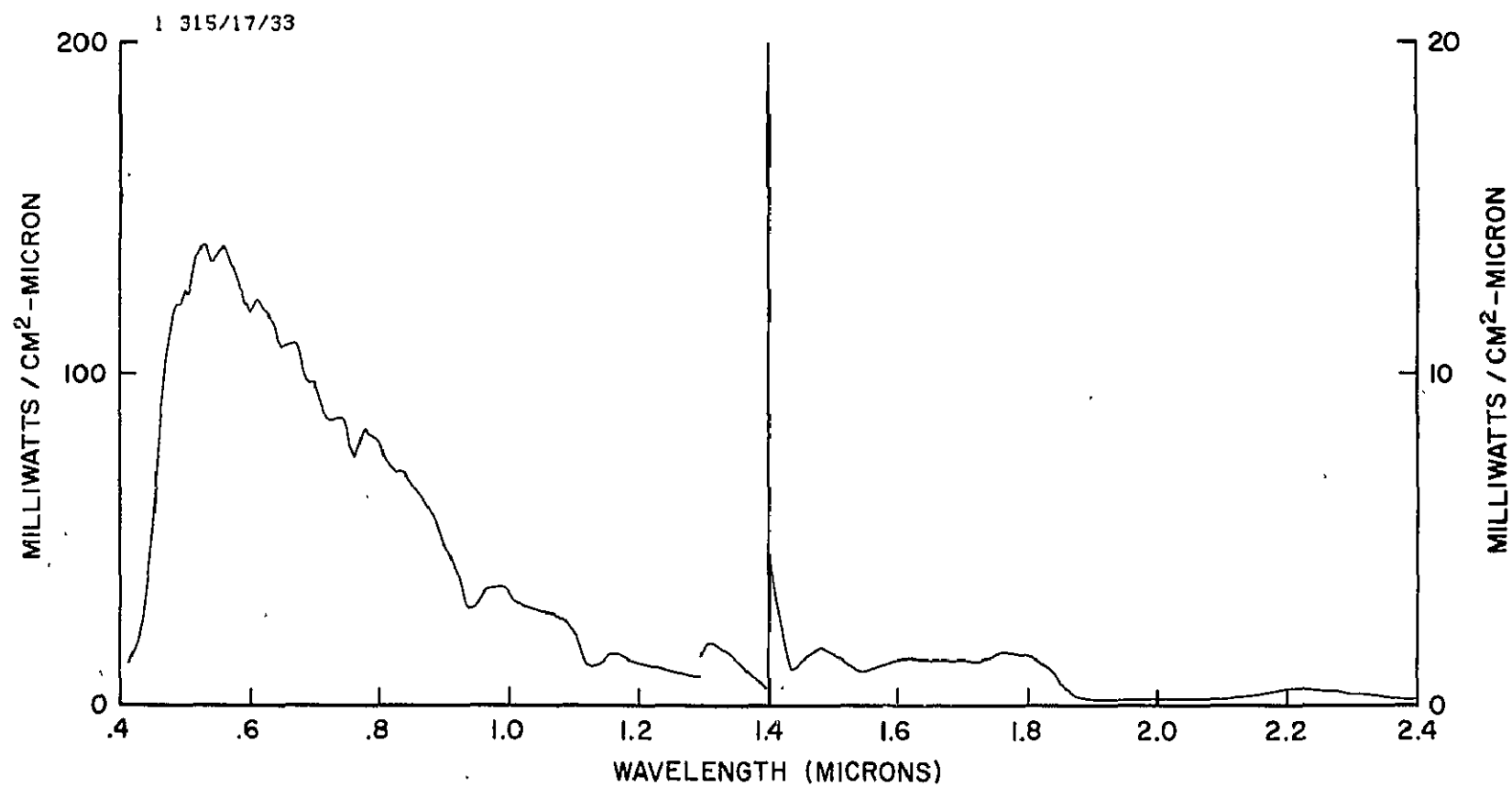










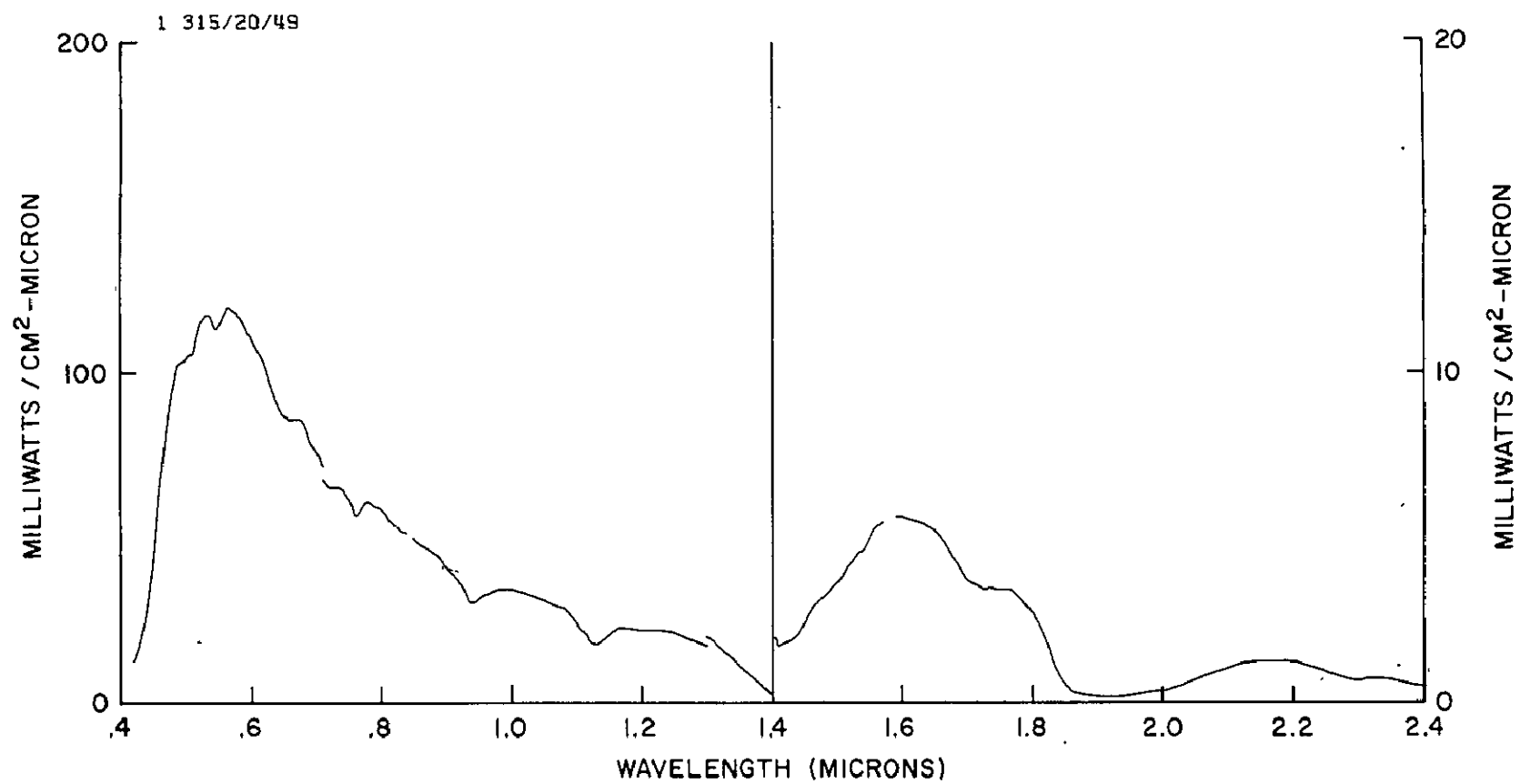


## VII. SNOWING CLOUD

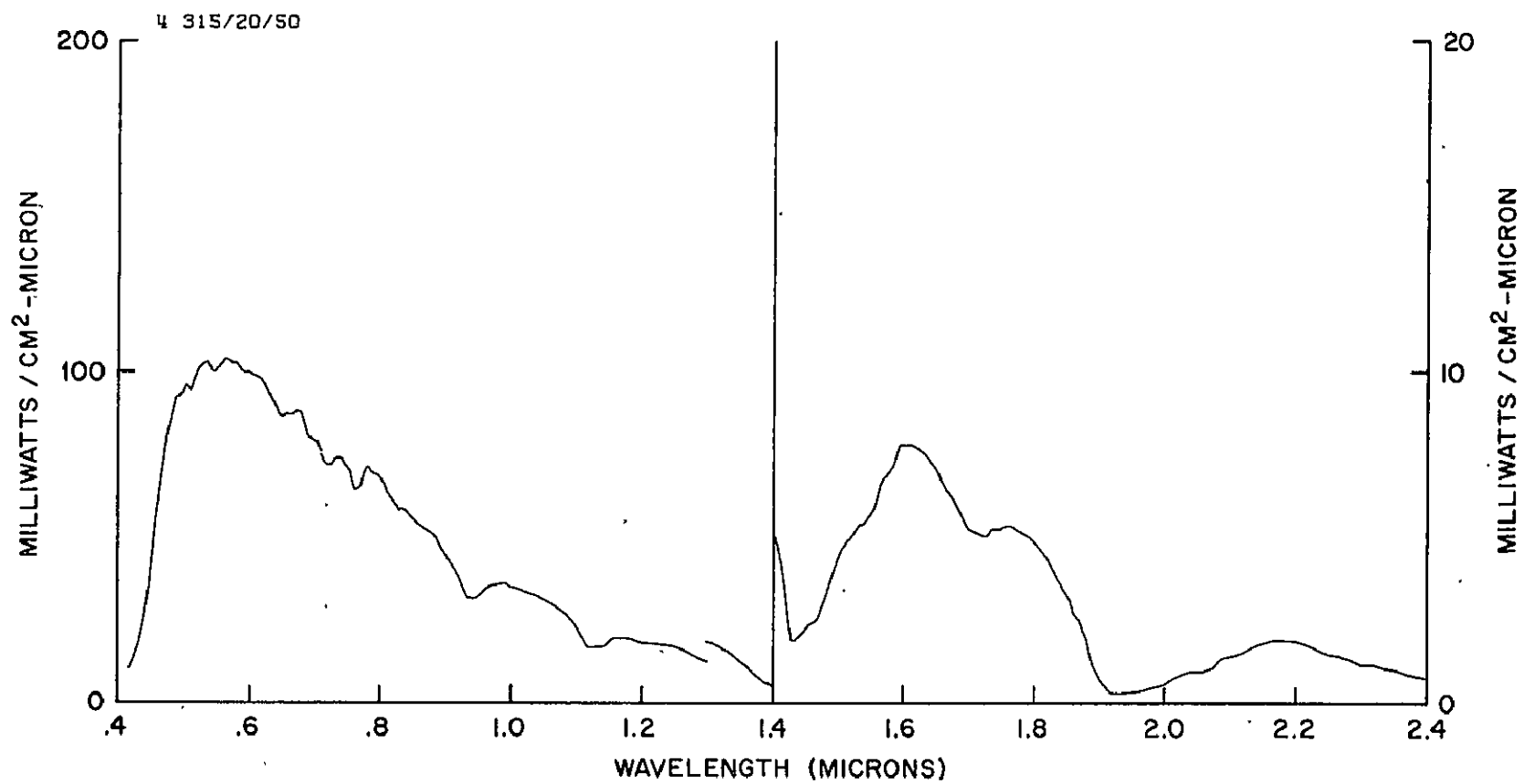
The following spectra was taken over a cloud observed to be precipitating snow. The cloud top was at an altitude of approximately 15,000 ft. (4.57 km) and the aircraft was at an altitude of 16,000 ft. (4.88 km). The cloud was located just west of Boulder, Colorado near Arapaho Peak. The sky above was clear.

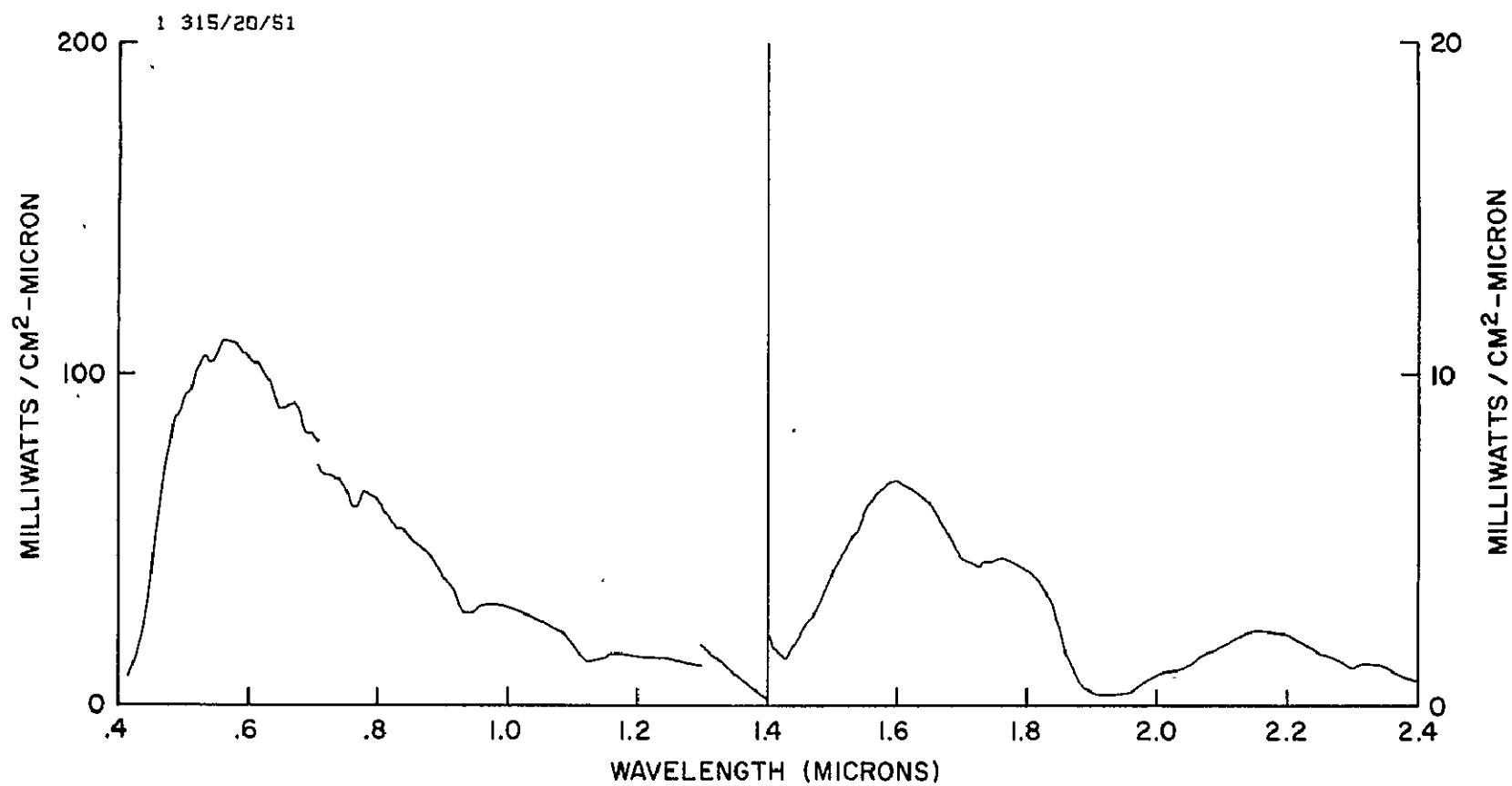
The spectra were taken between 20 hrs. 49 mins. and 20 hrs. 57 mins. Universal Time.





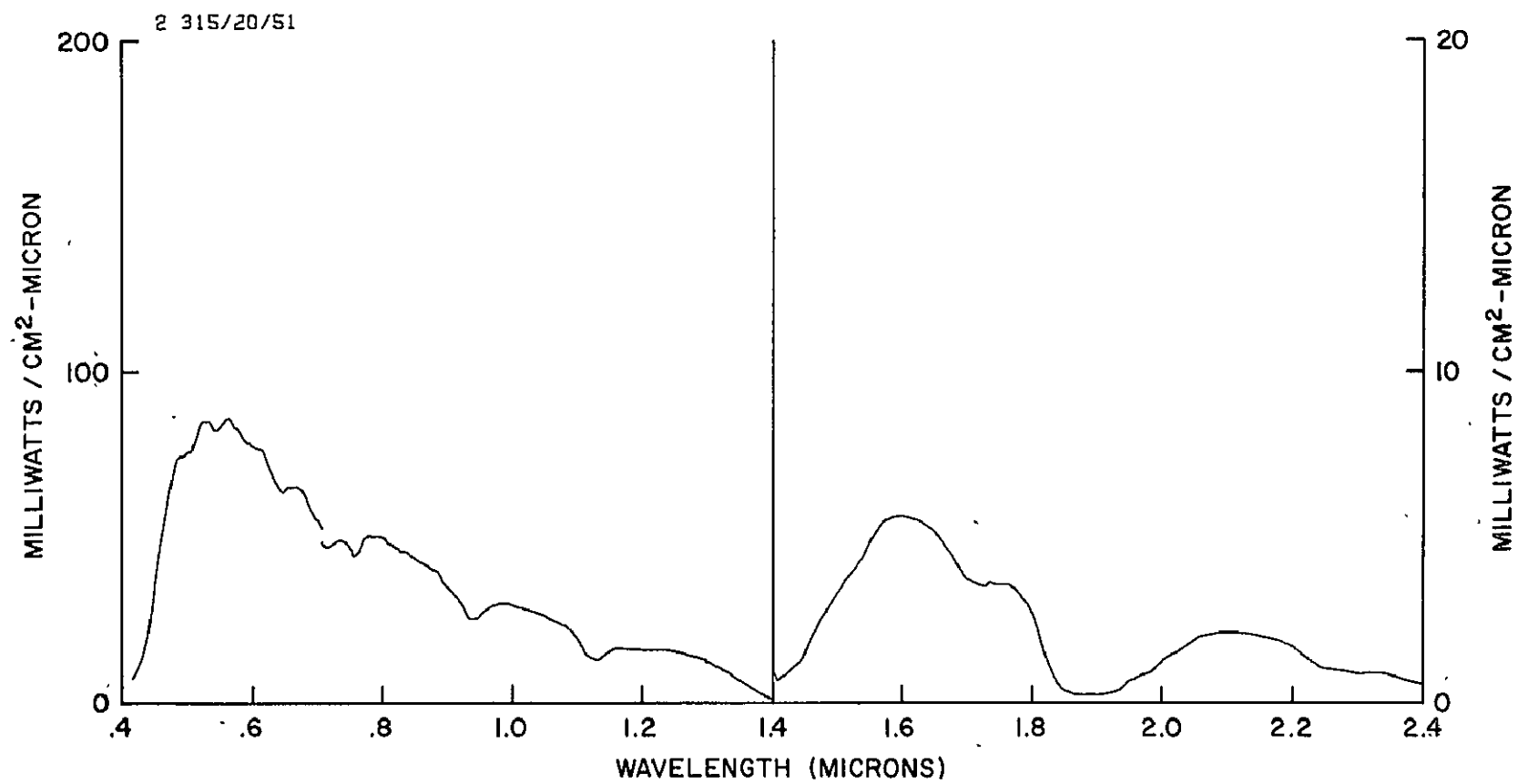
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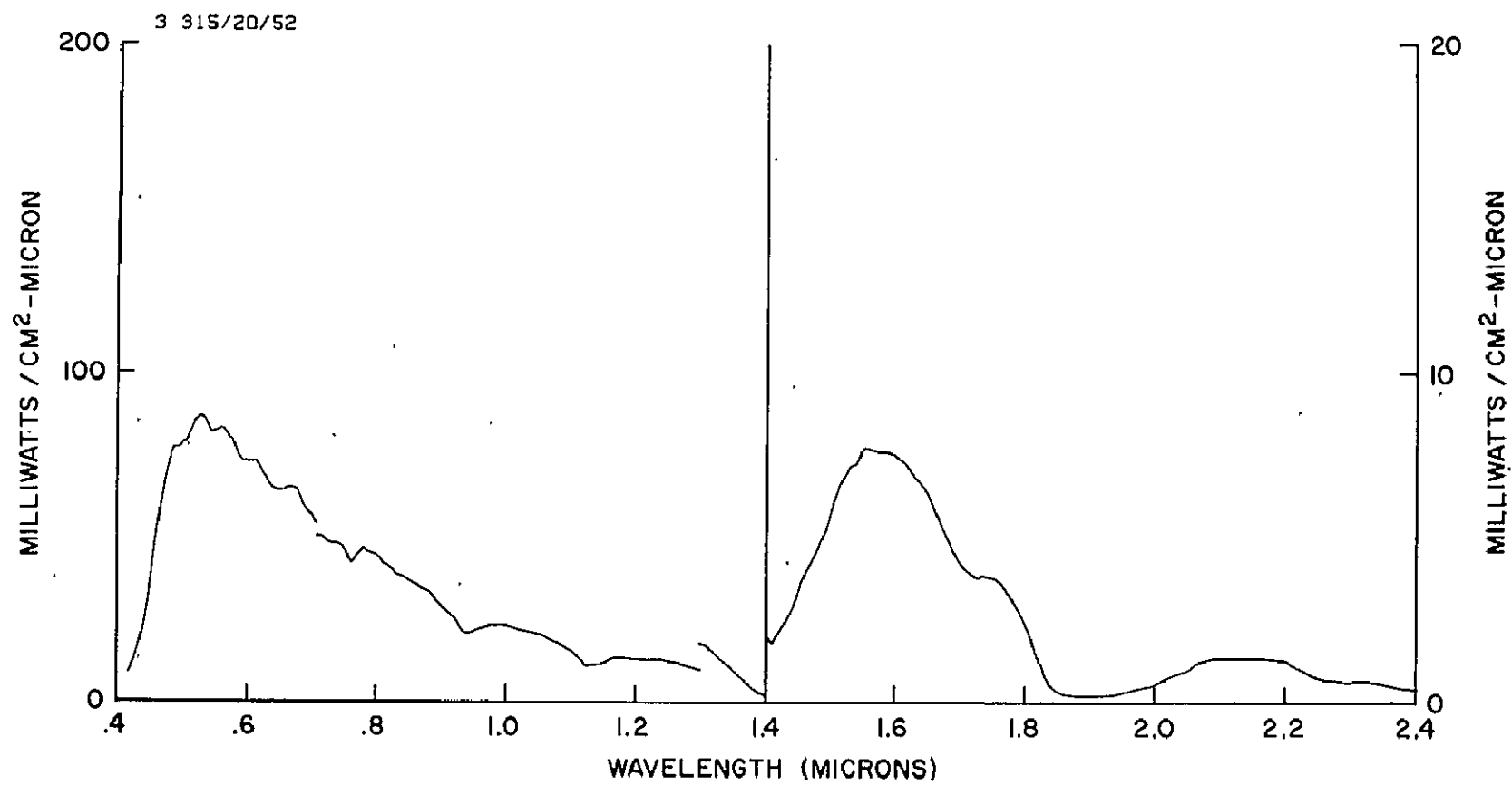


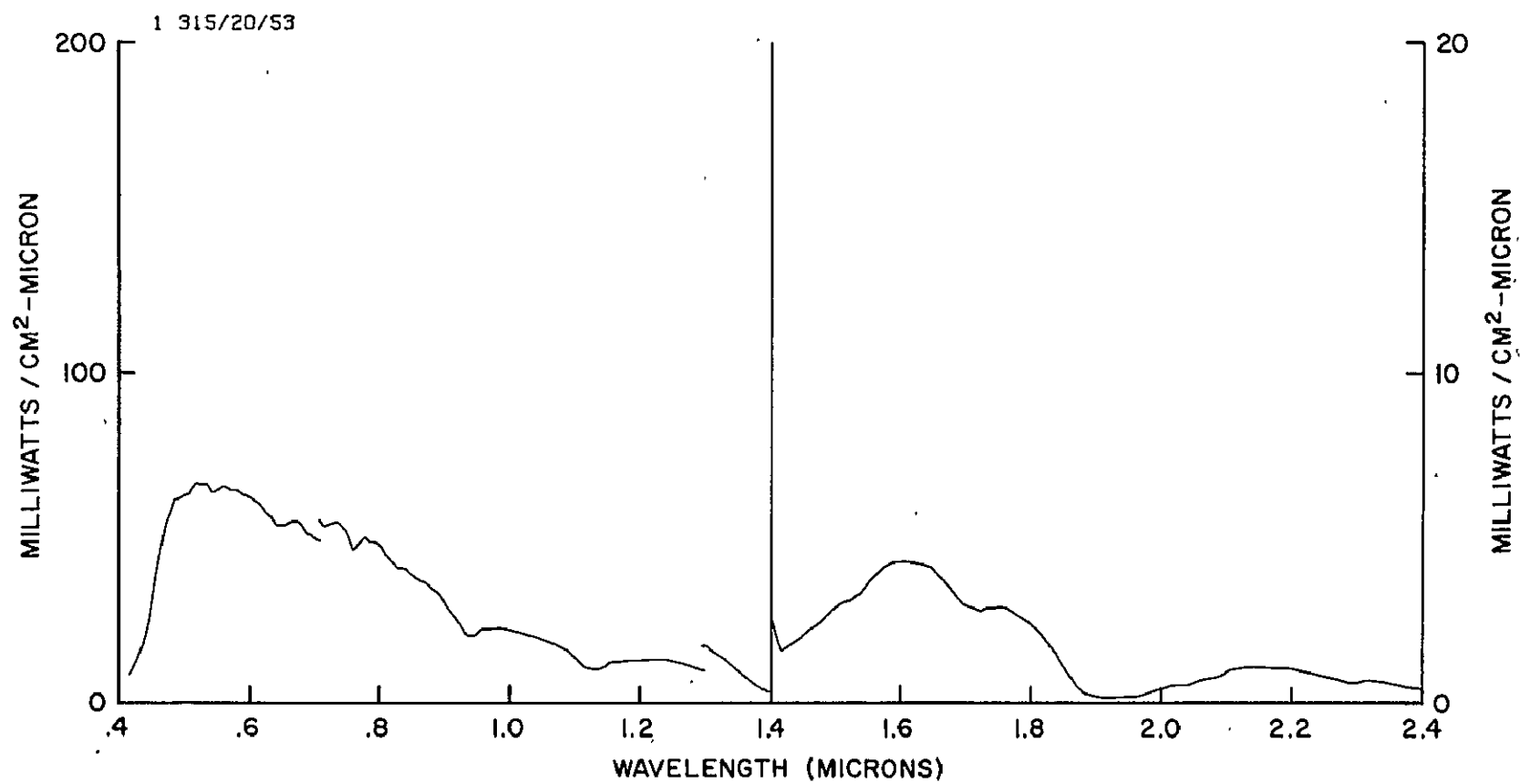


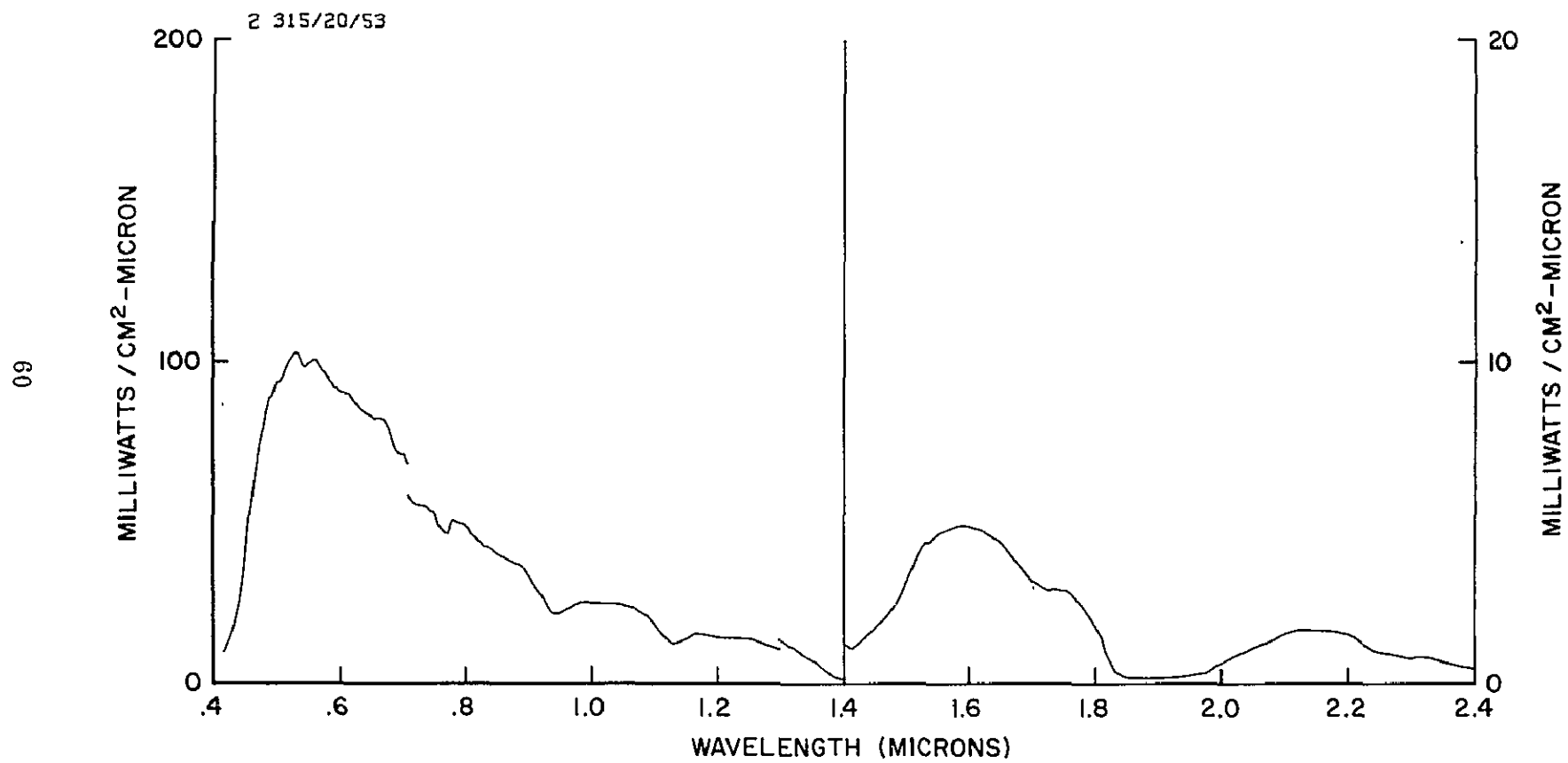
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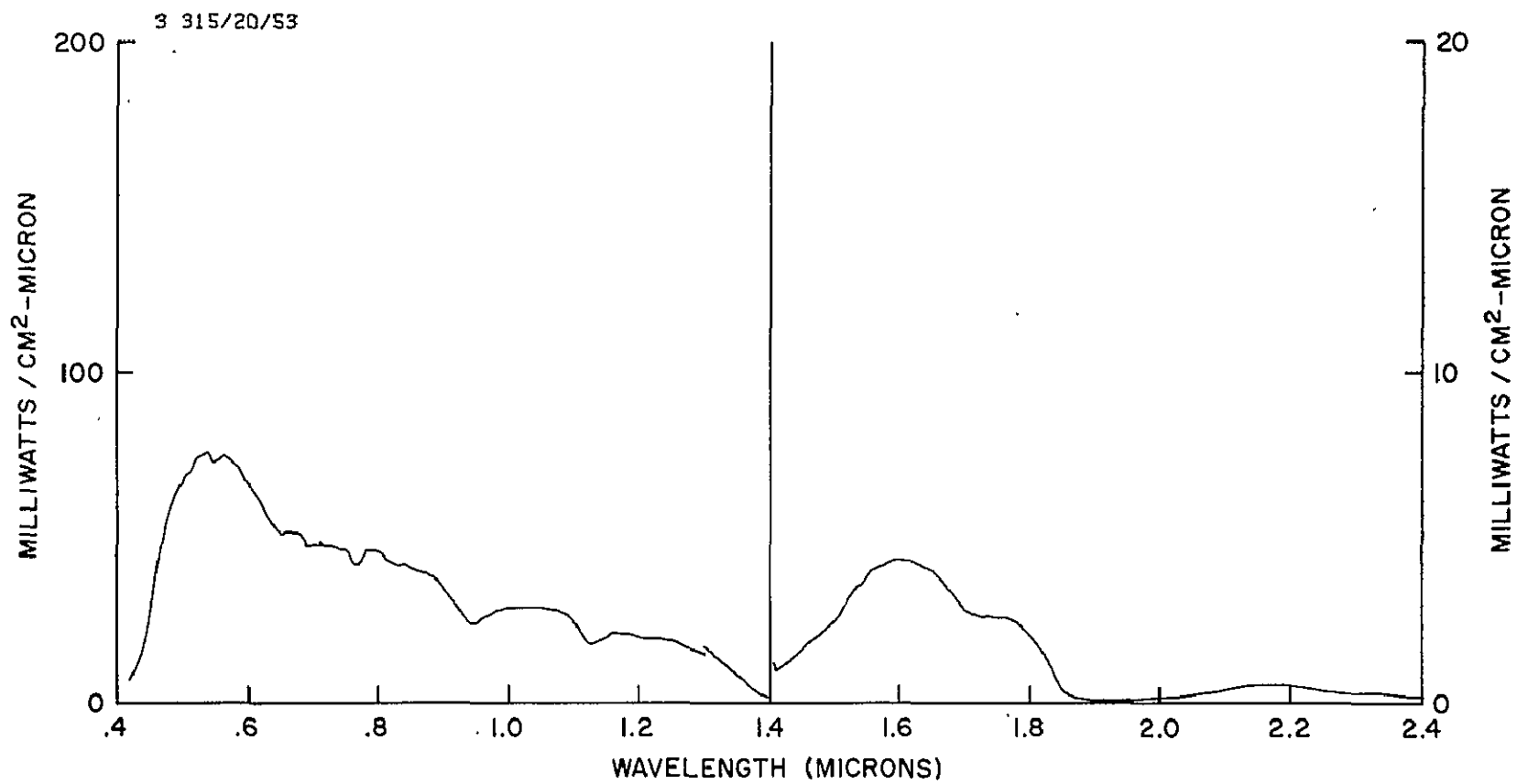
57



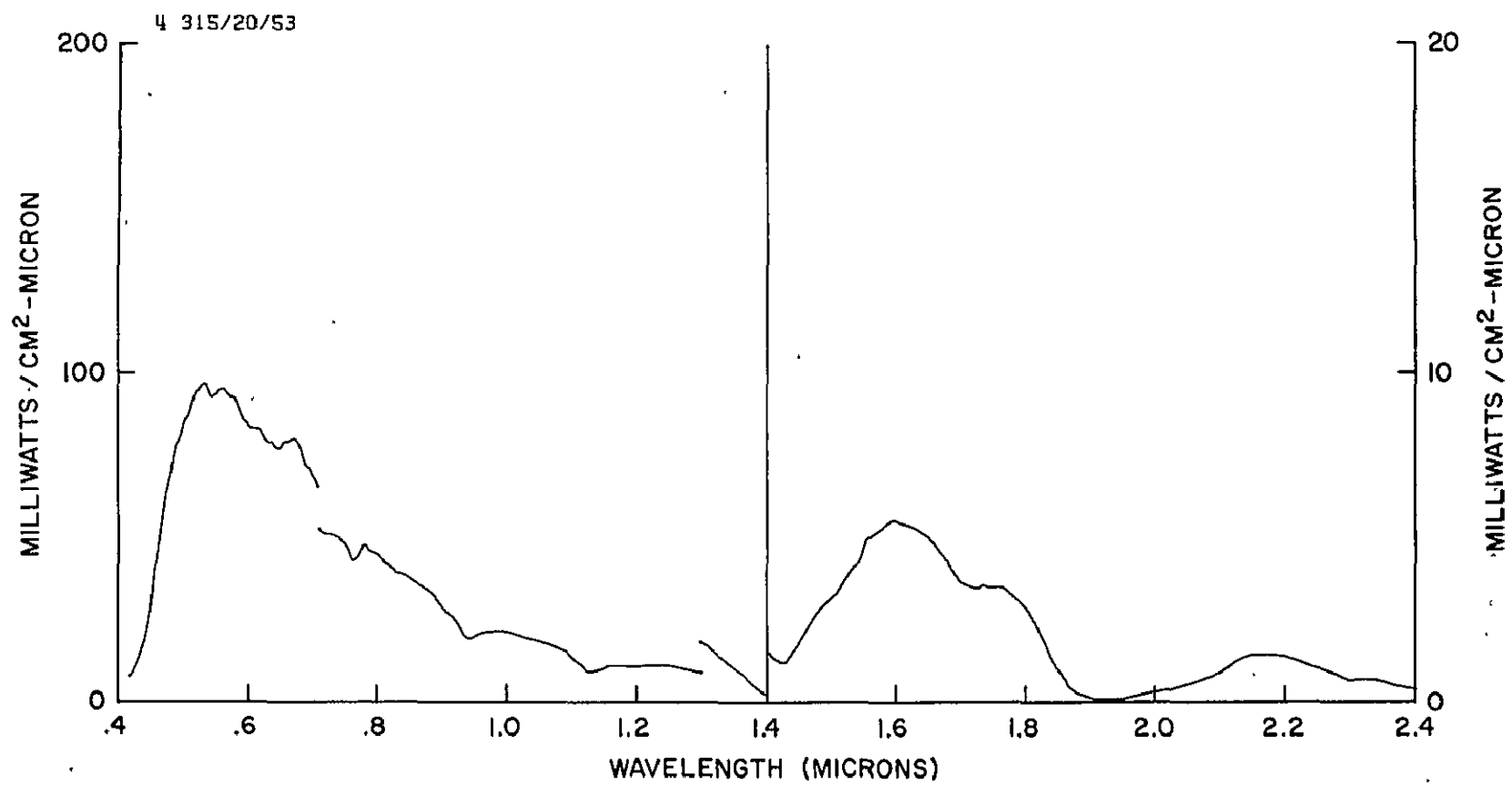


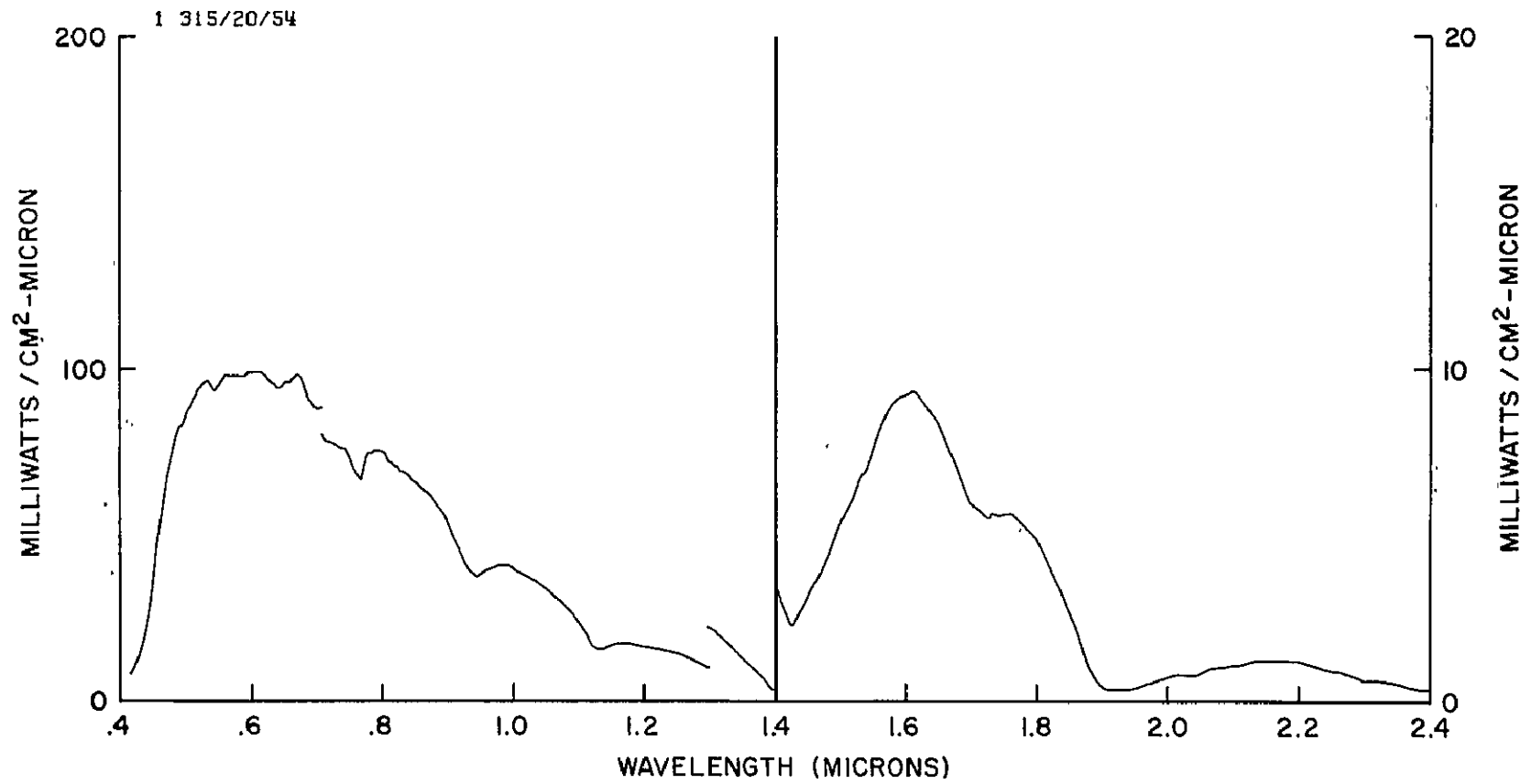


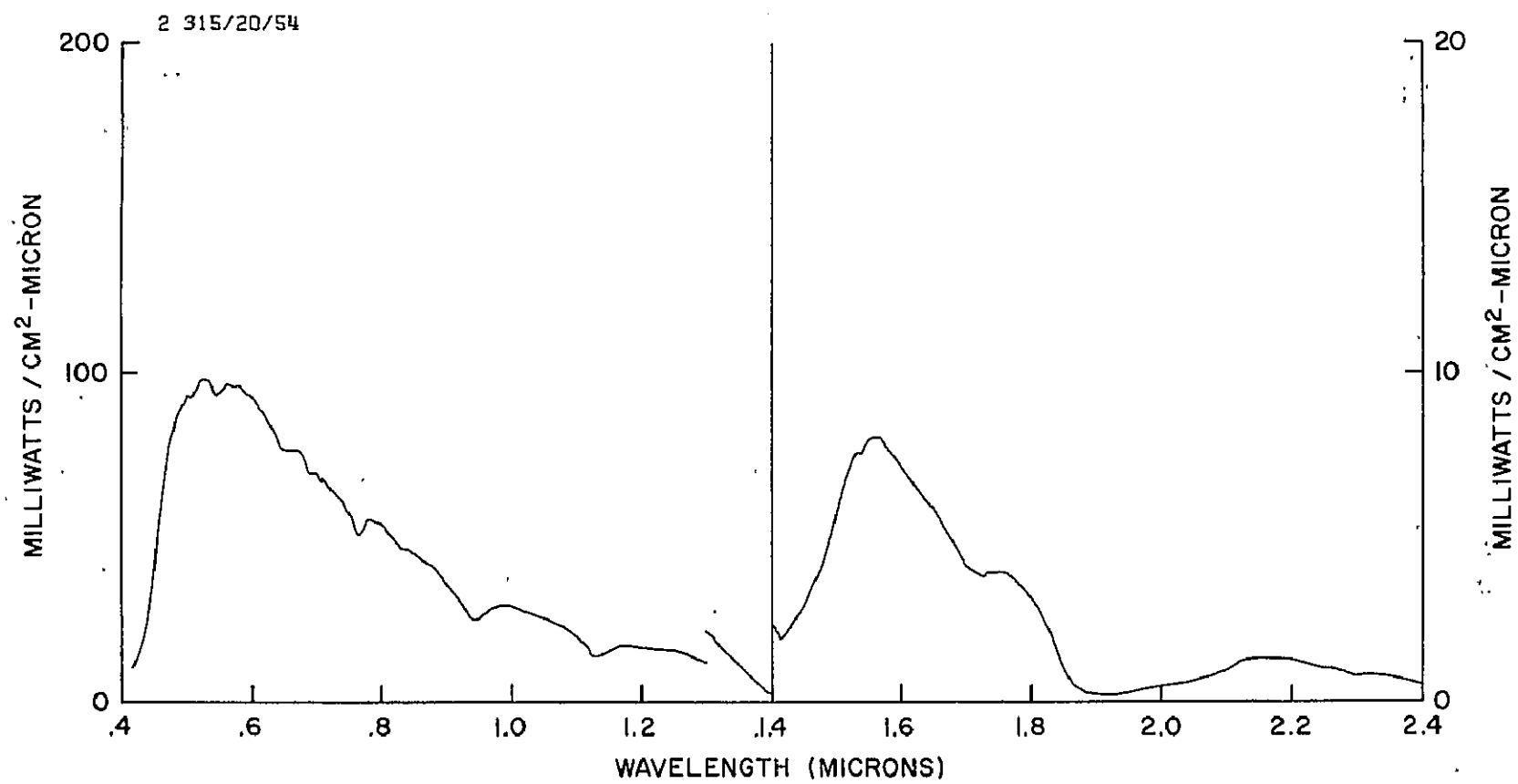


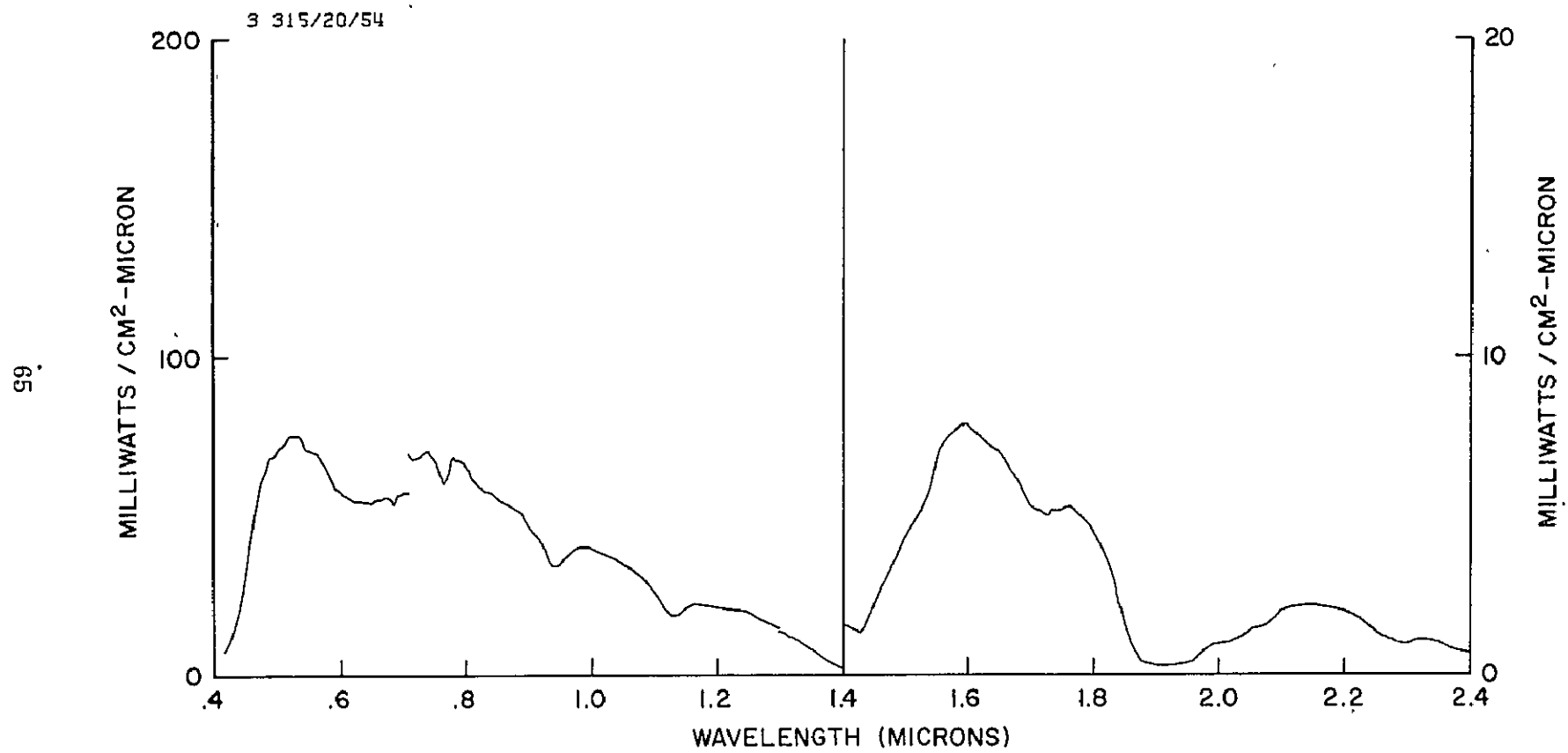


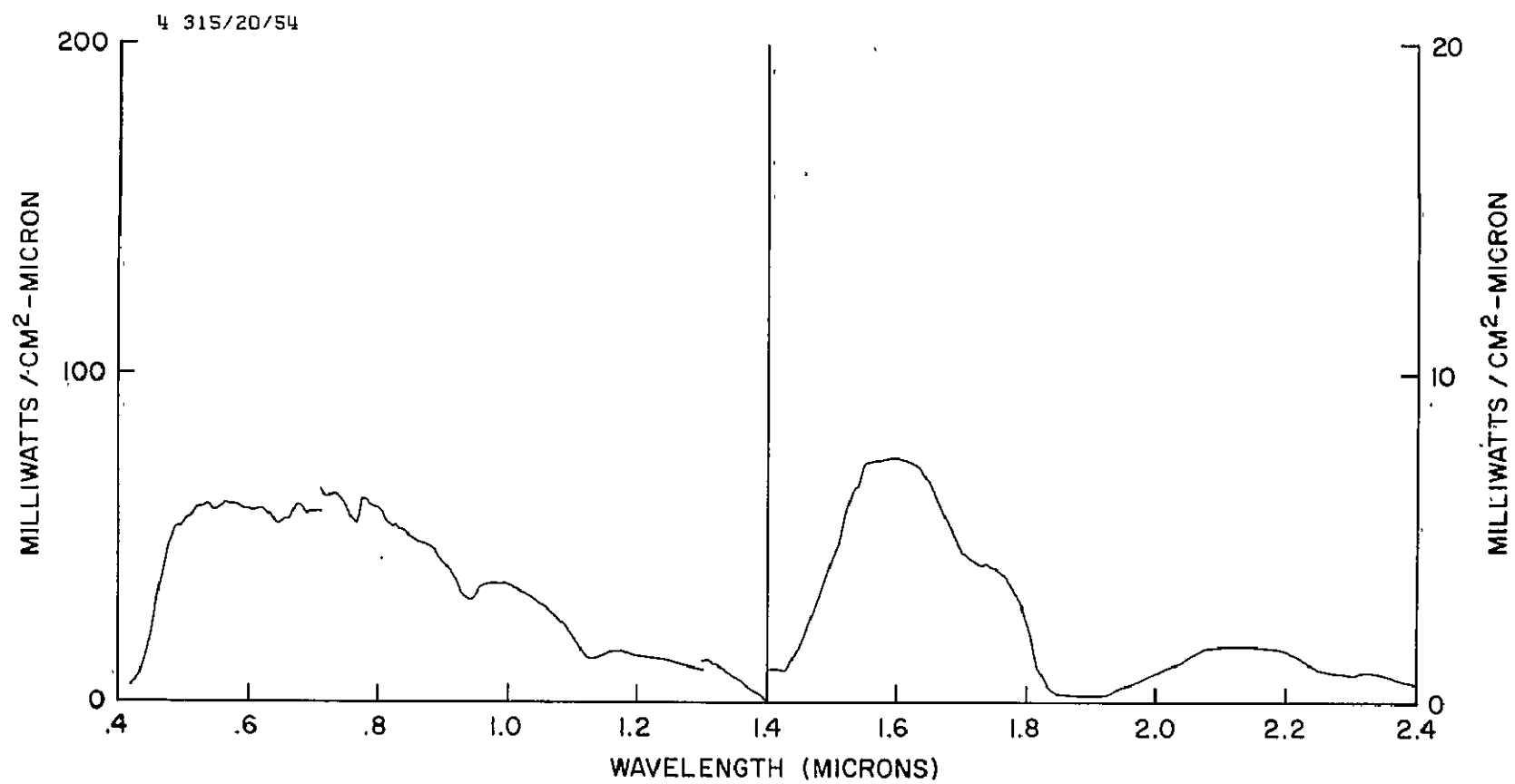


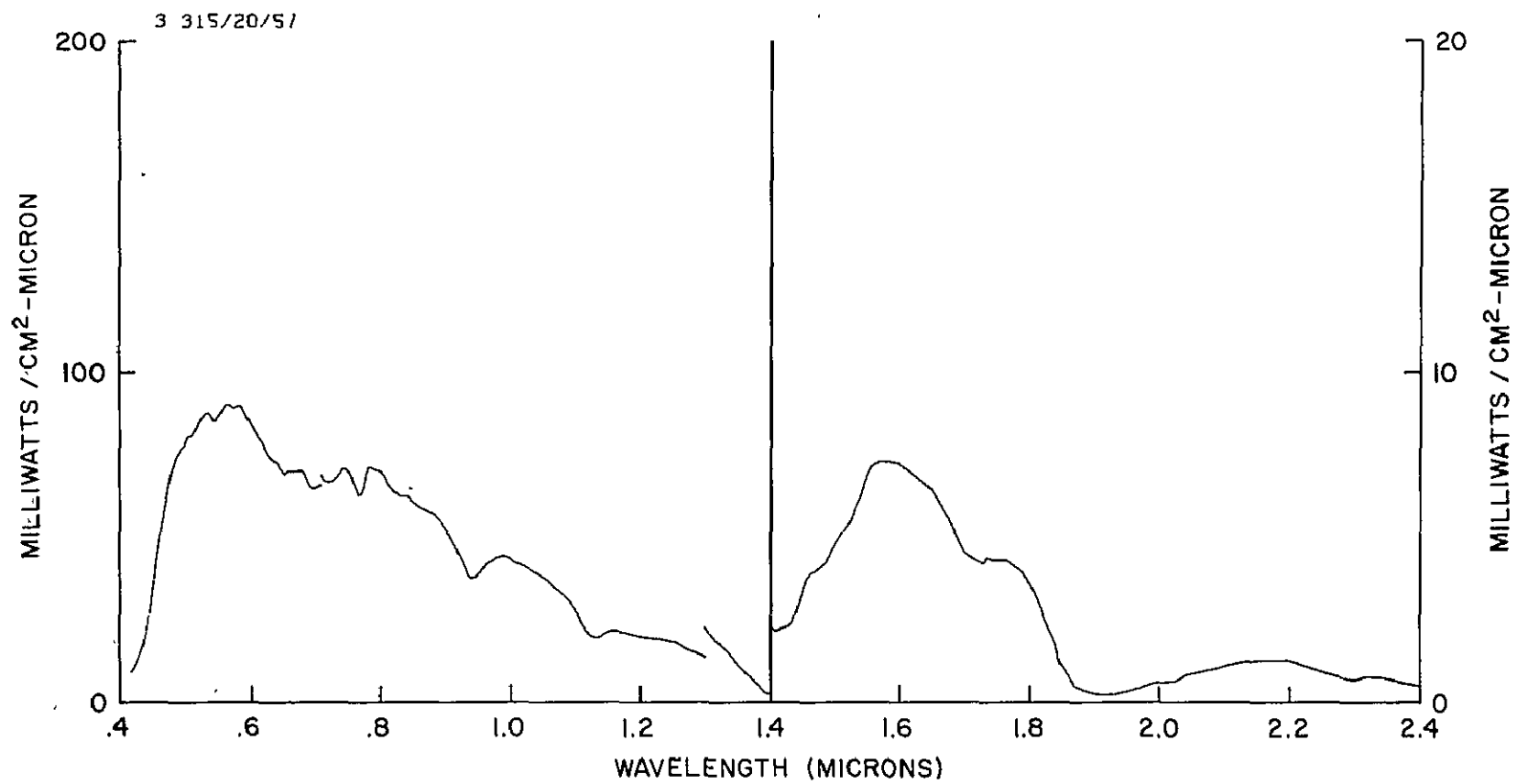


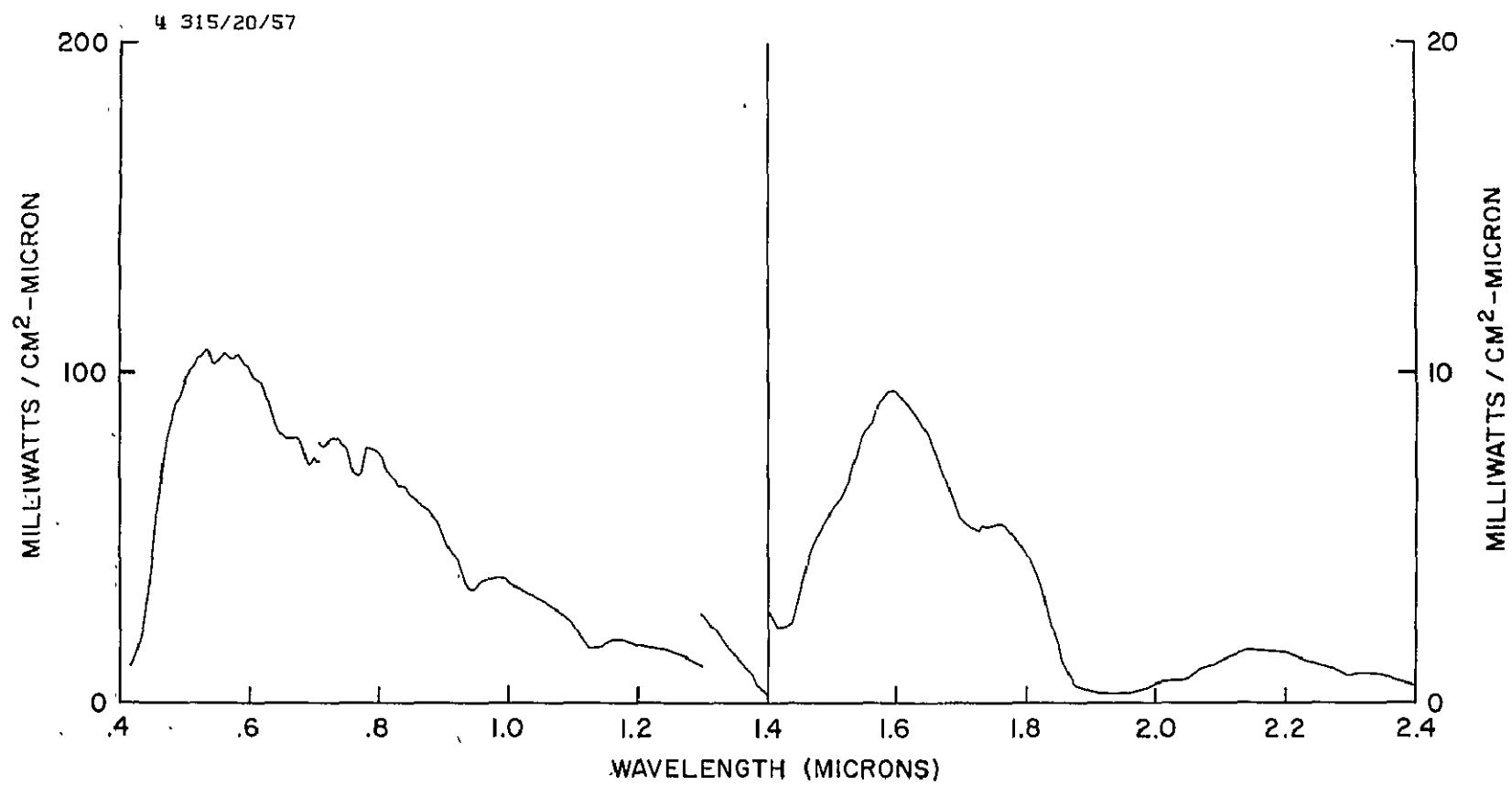


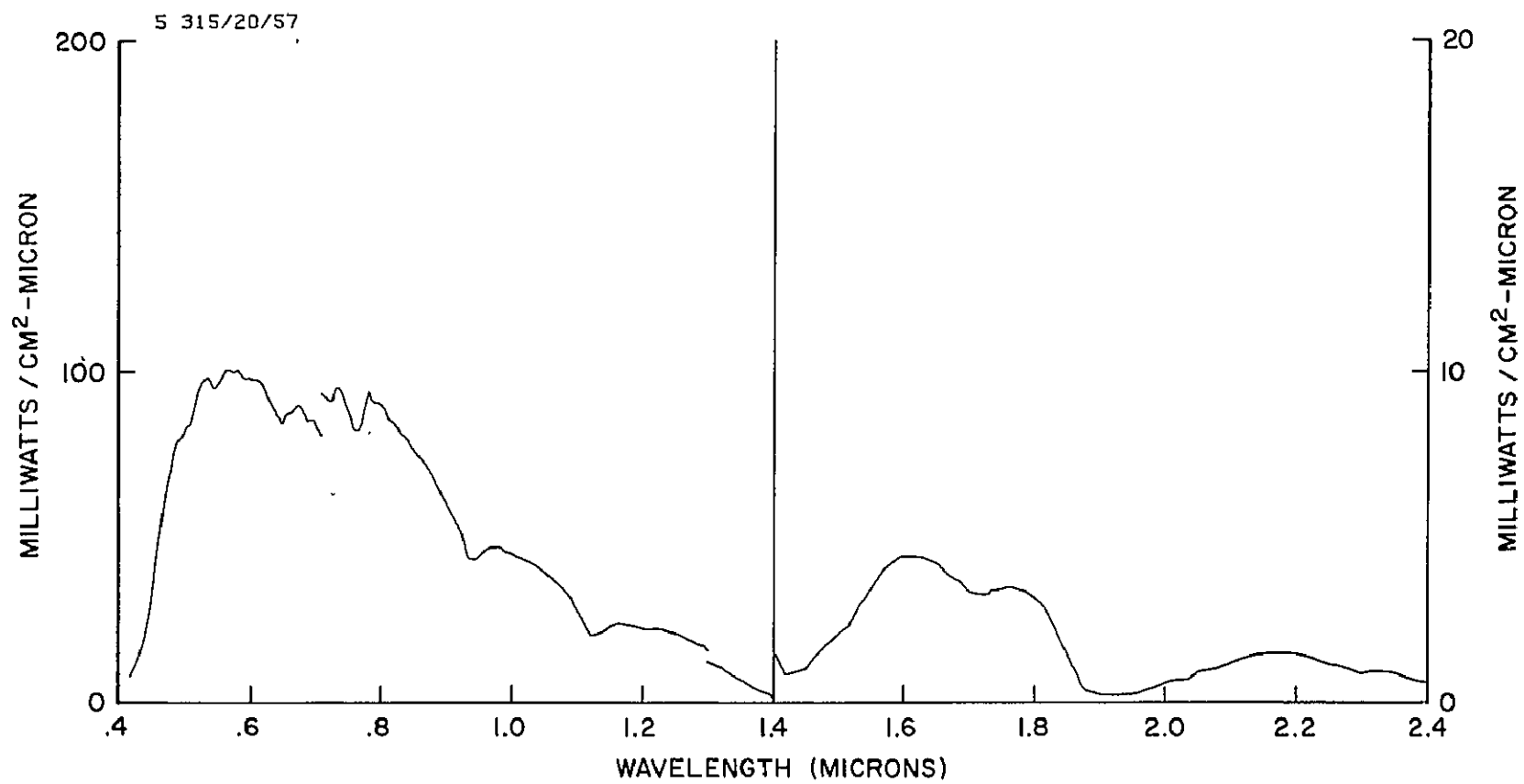










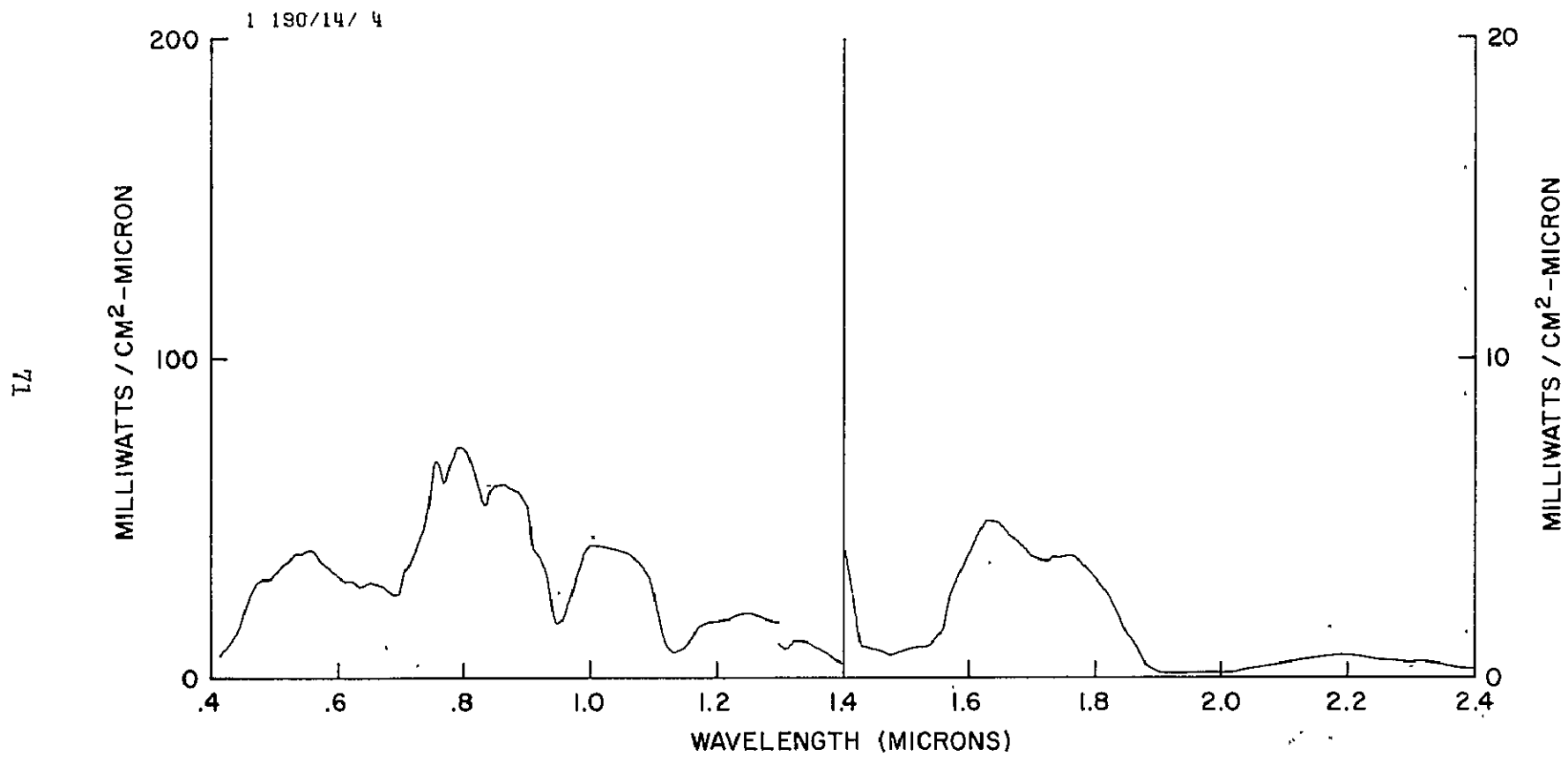


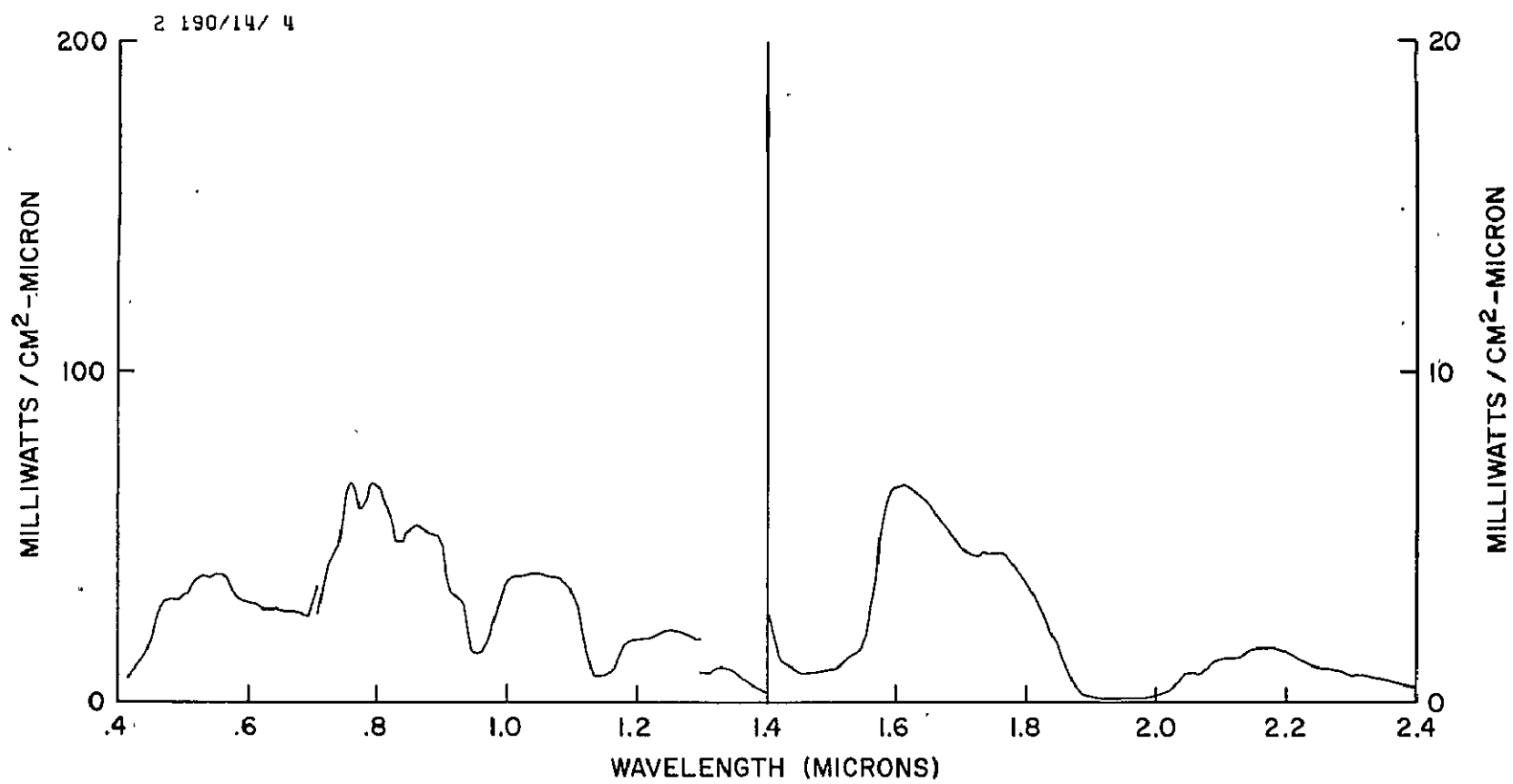


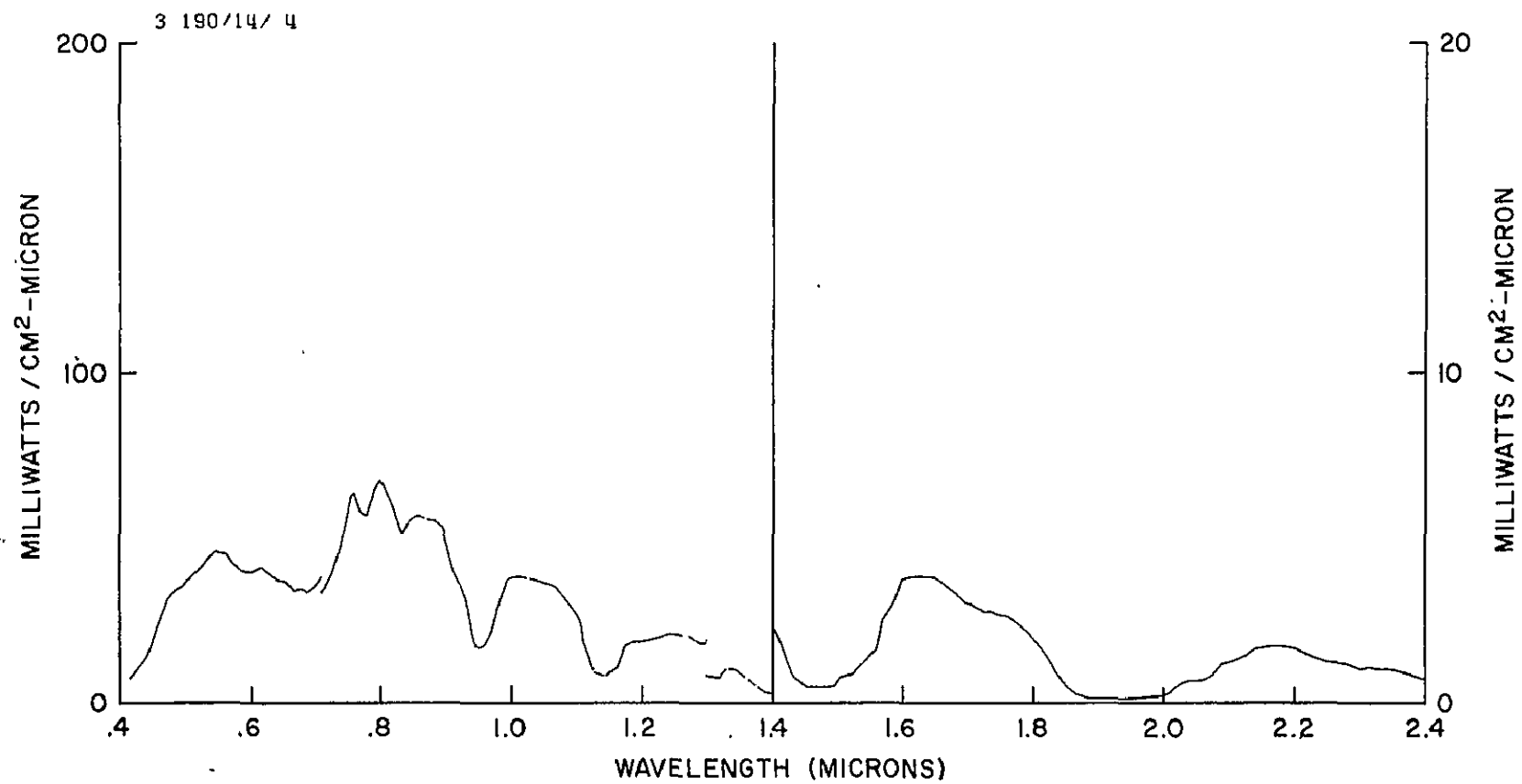
### VIII. FIELDS, JAMESTOWN, N.D.

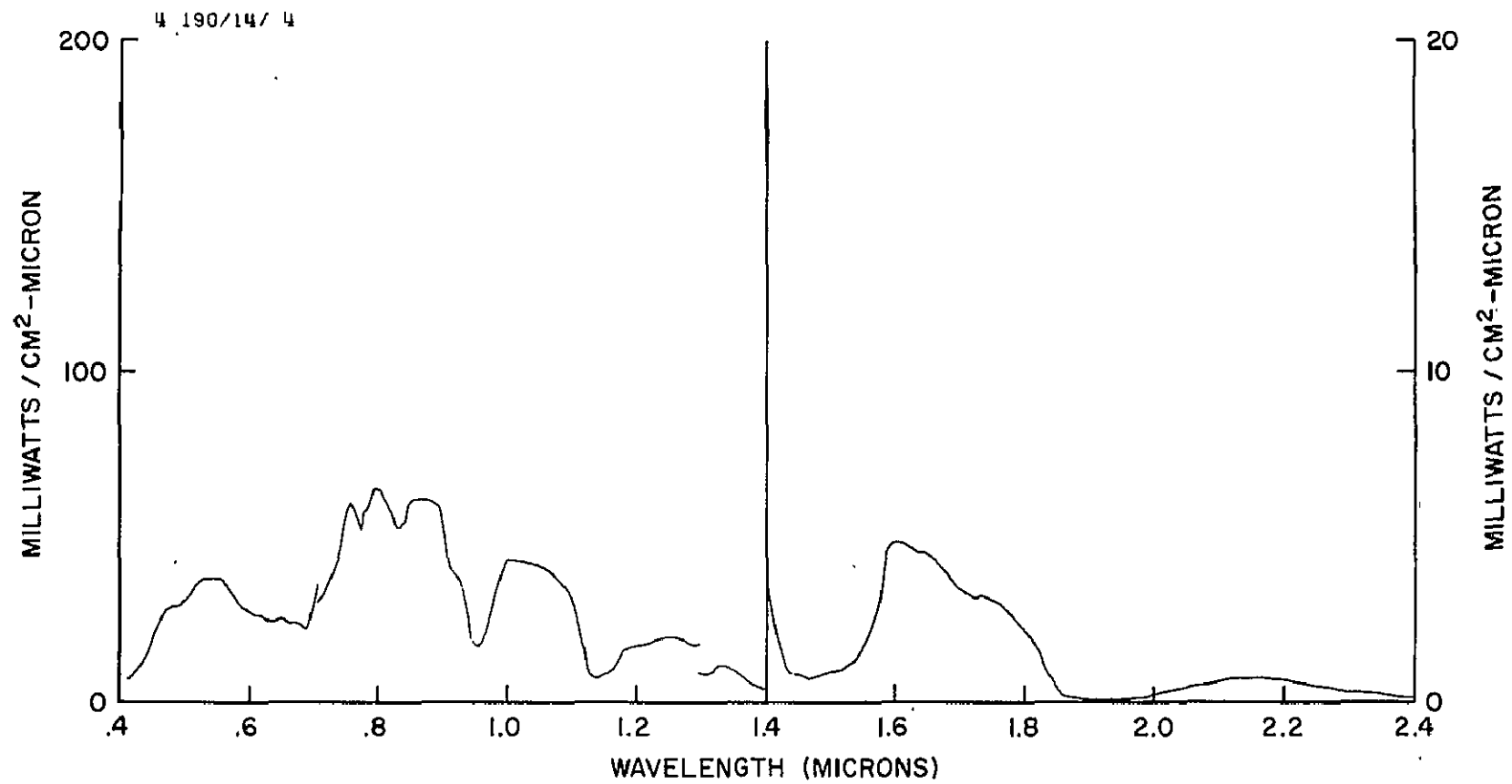
The following spectra were taken from the NASA C47 aircraft of Lewis Research Center piloted by William Swann and Byron Batthauer and crewed by George Ford, all of NASA-Lewis Research Center. The area chosen was 19 miles southeast of Jamestown, N.D. This area had appeared quite uniform in reflectance from the Nimbus III HRIR and was easily located due to the presence of several nearby lakes that are prominent in daylight imagery of the area. The fields were all covered with green vegetation consisting of wheat and grass cover.

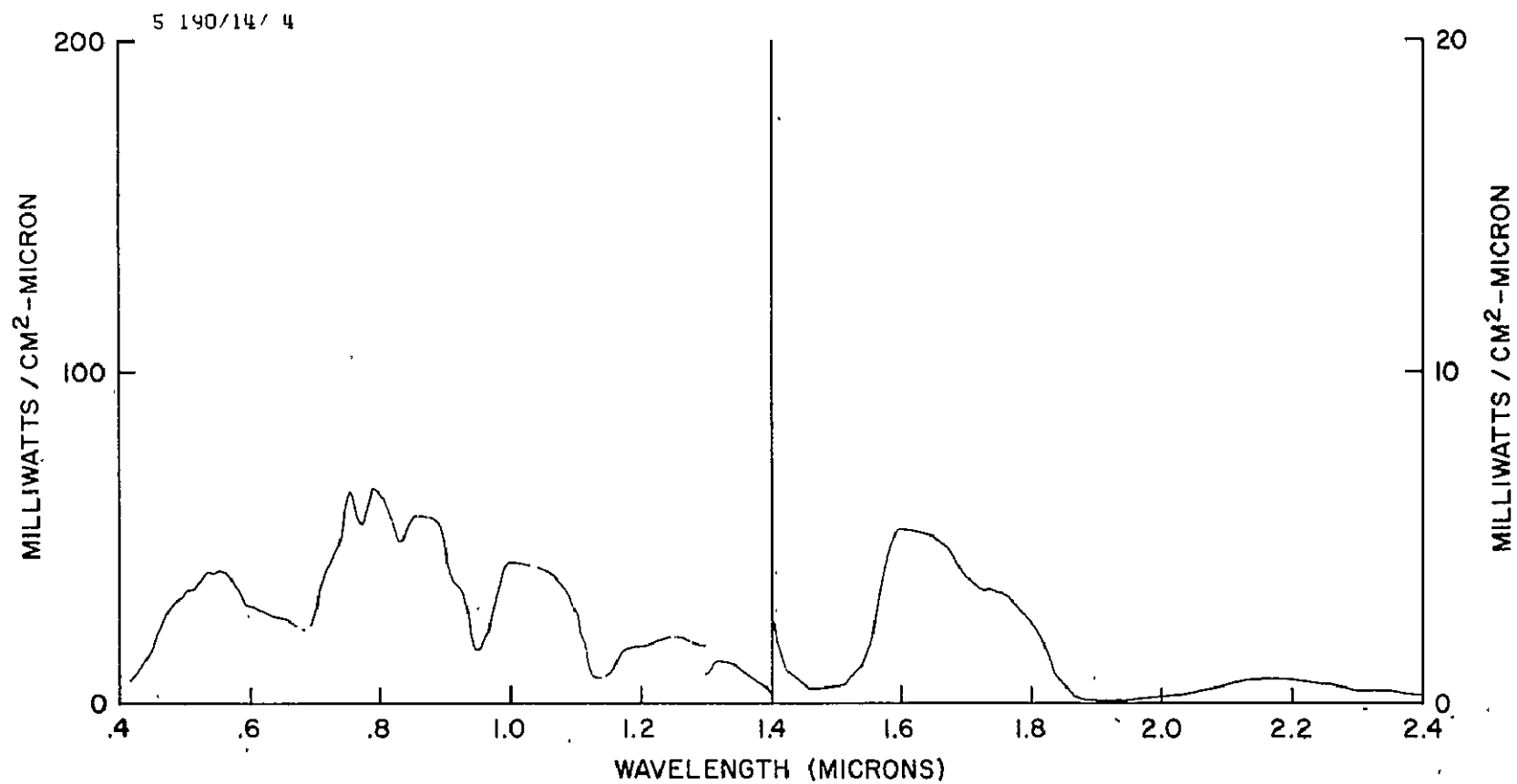
The spectra were taken on July 9, 1971 (Julian Day 190) with the plane at an altitude of 16,500 feet (5.03 km). The spectra were taken between 14 hrs. 4 mins. and 14 hrs. 44 mins. Universal Time. The sky above was clear.

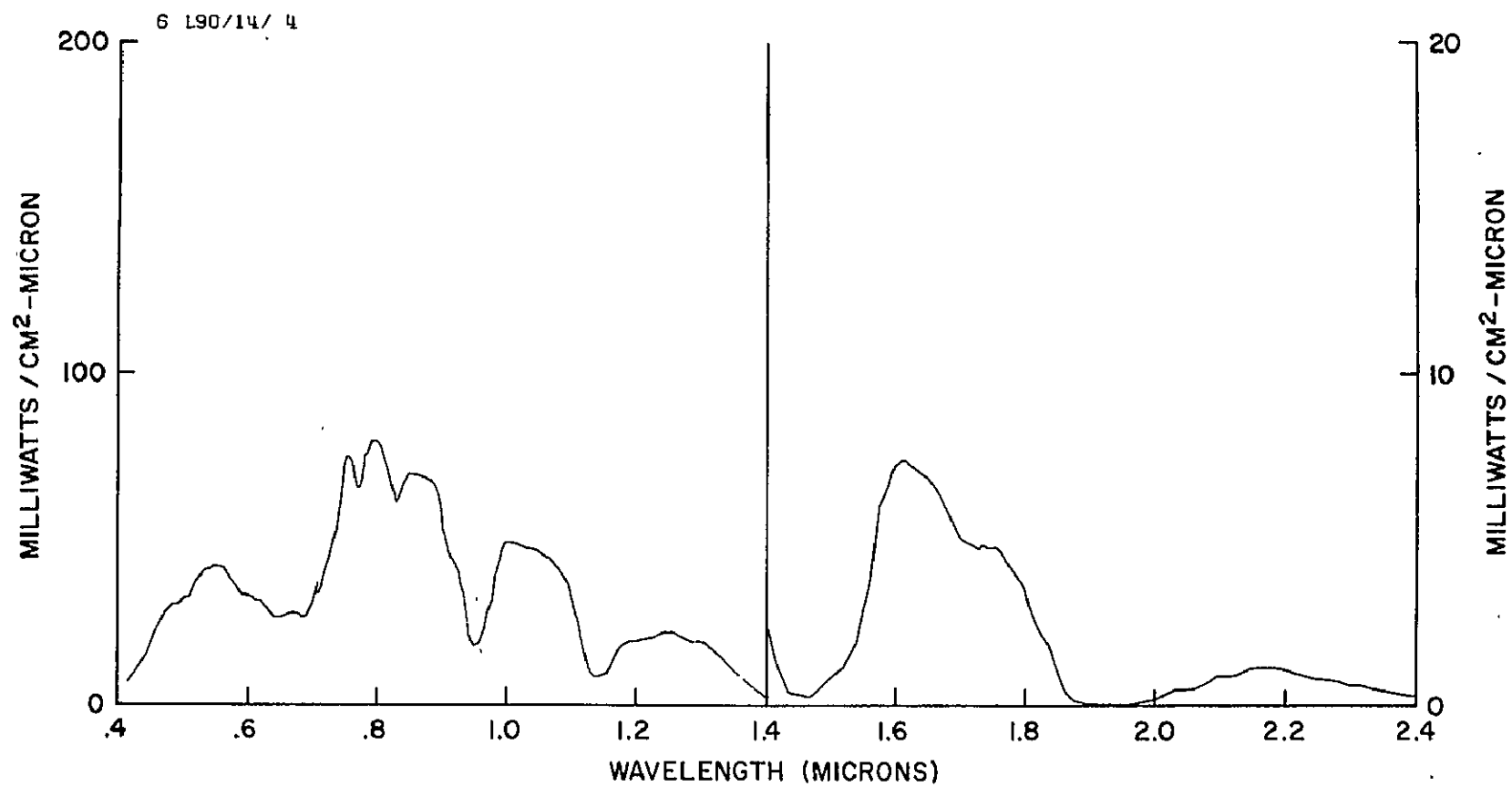


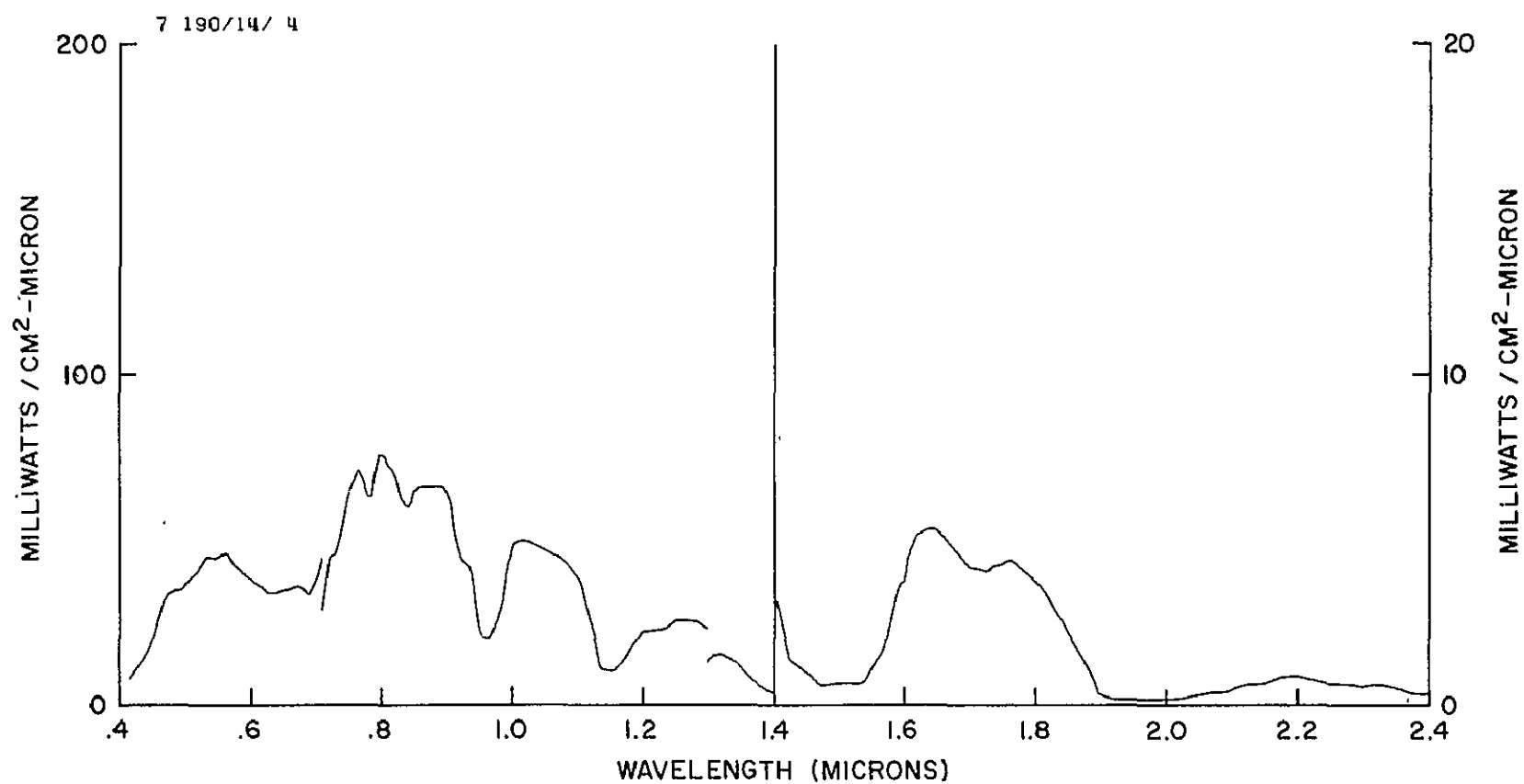




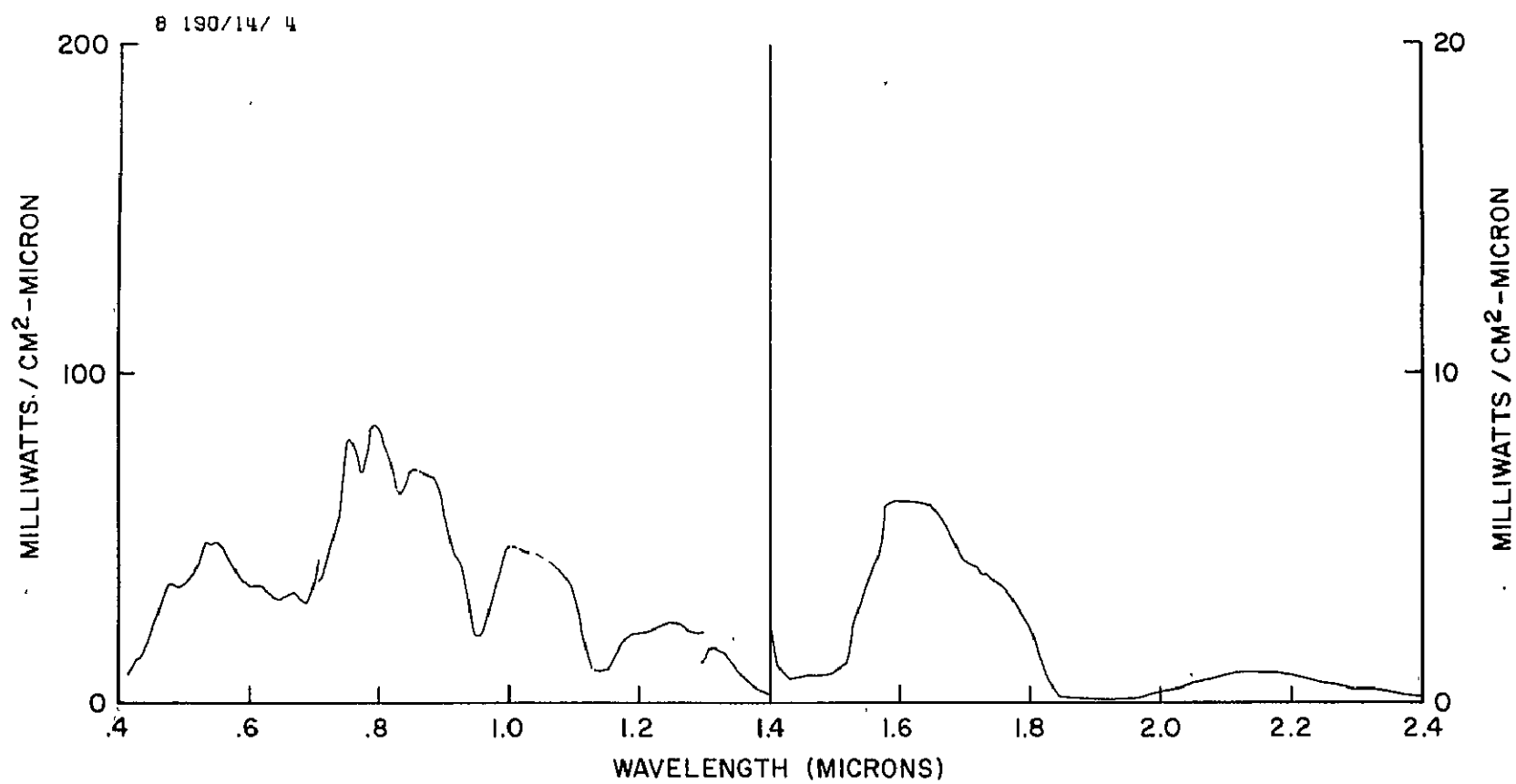


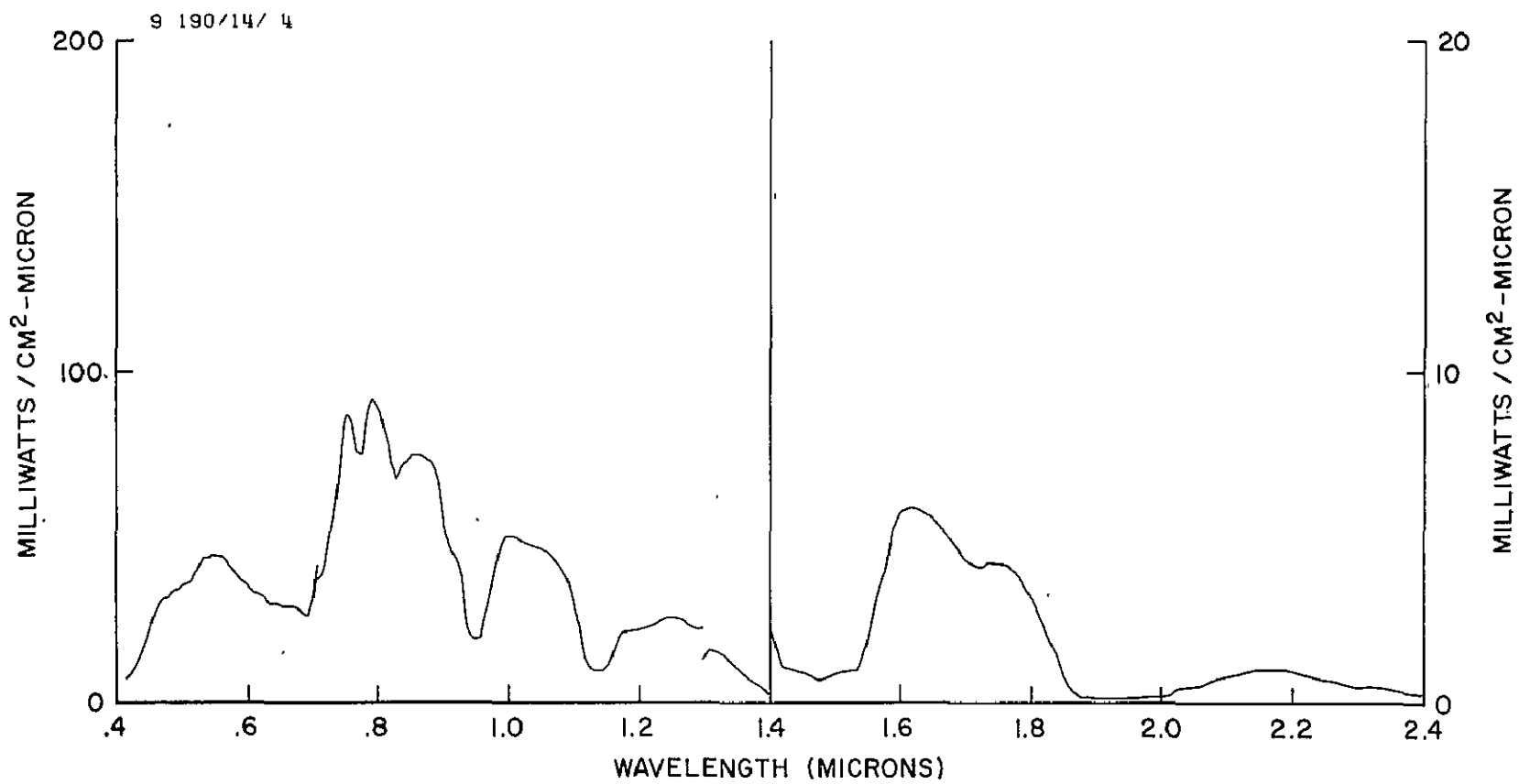


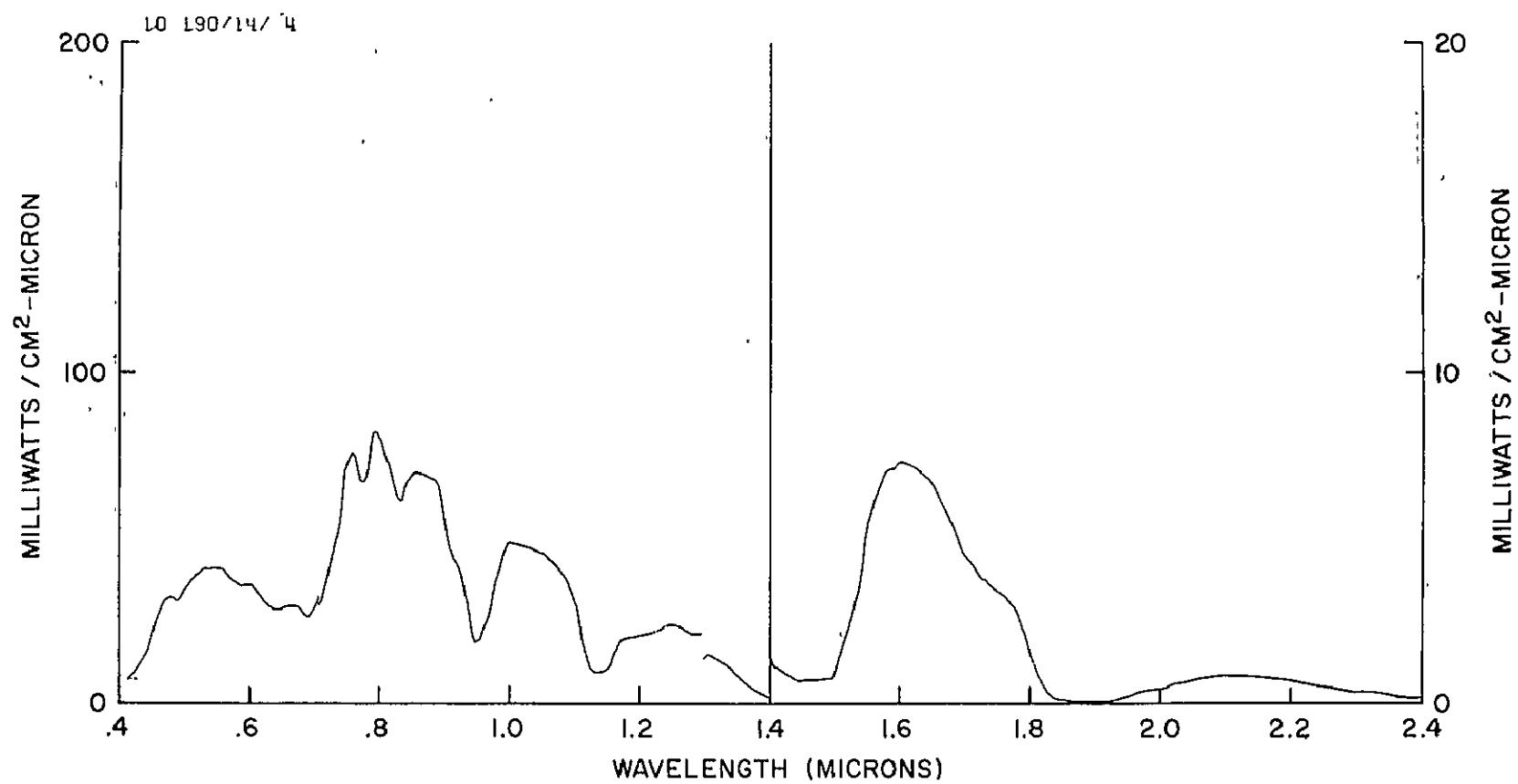


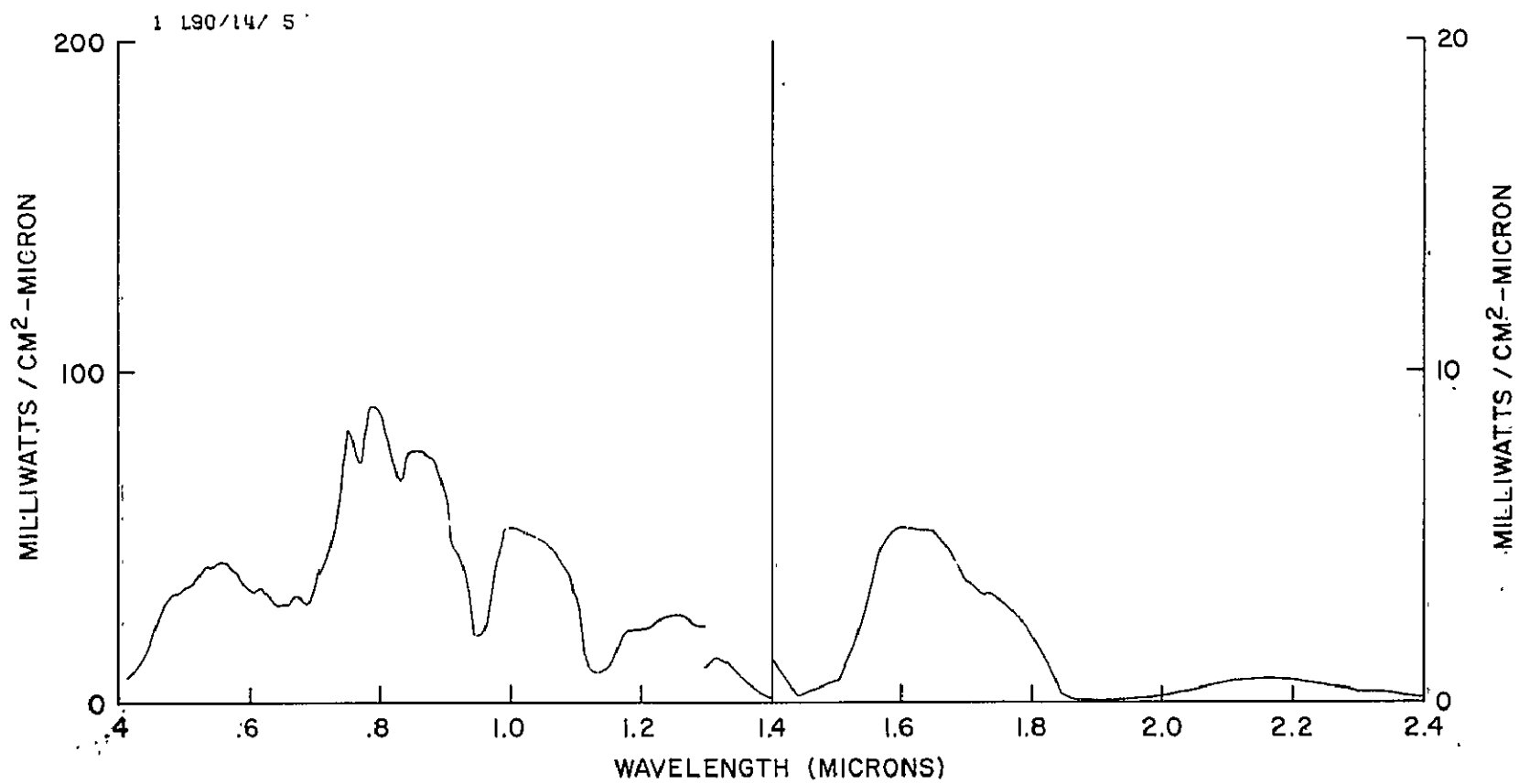


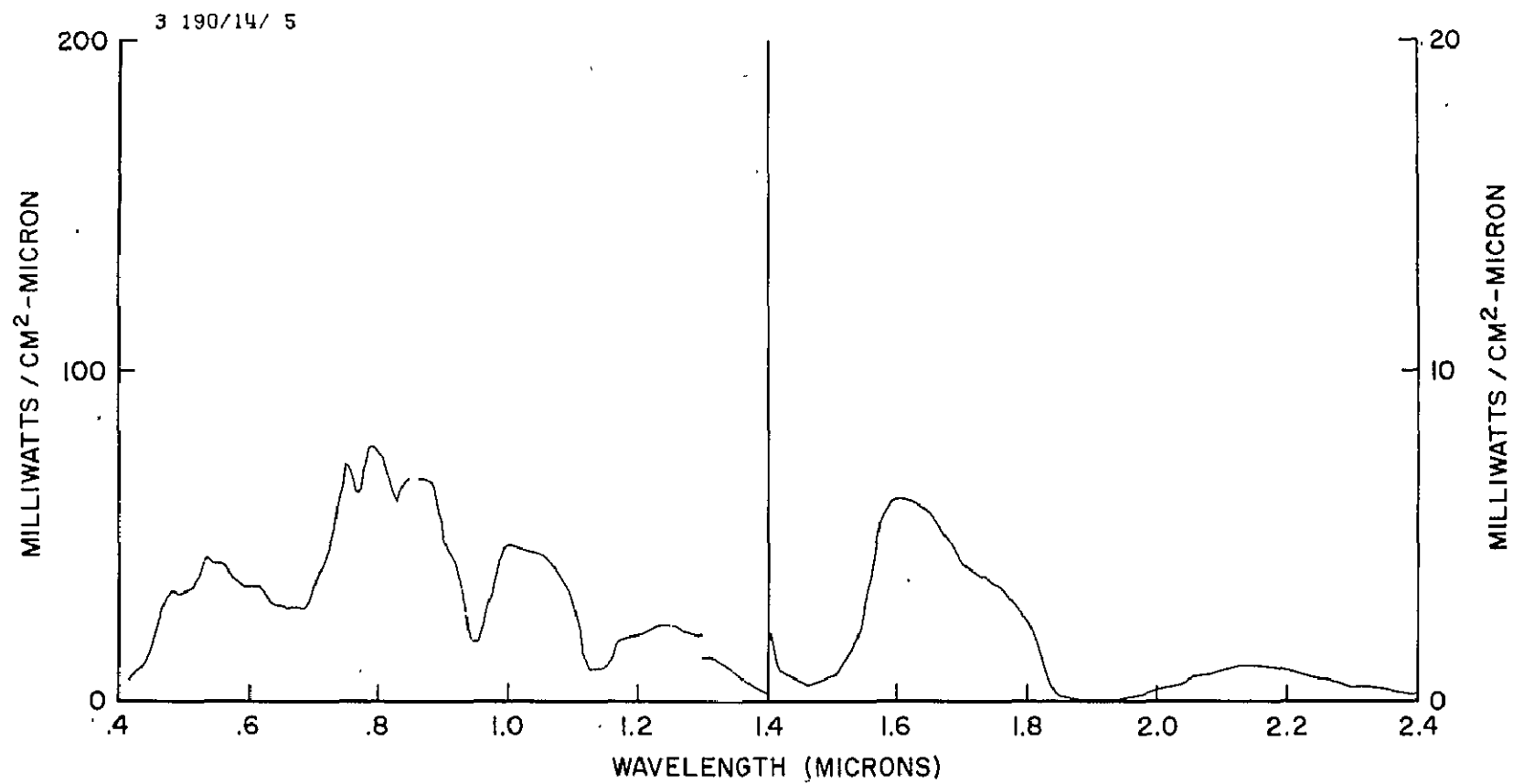


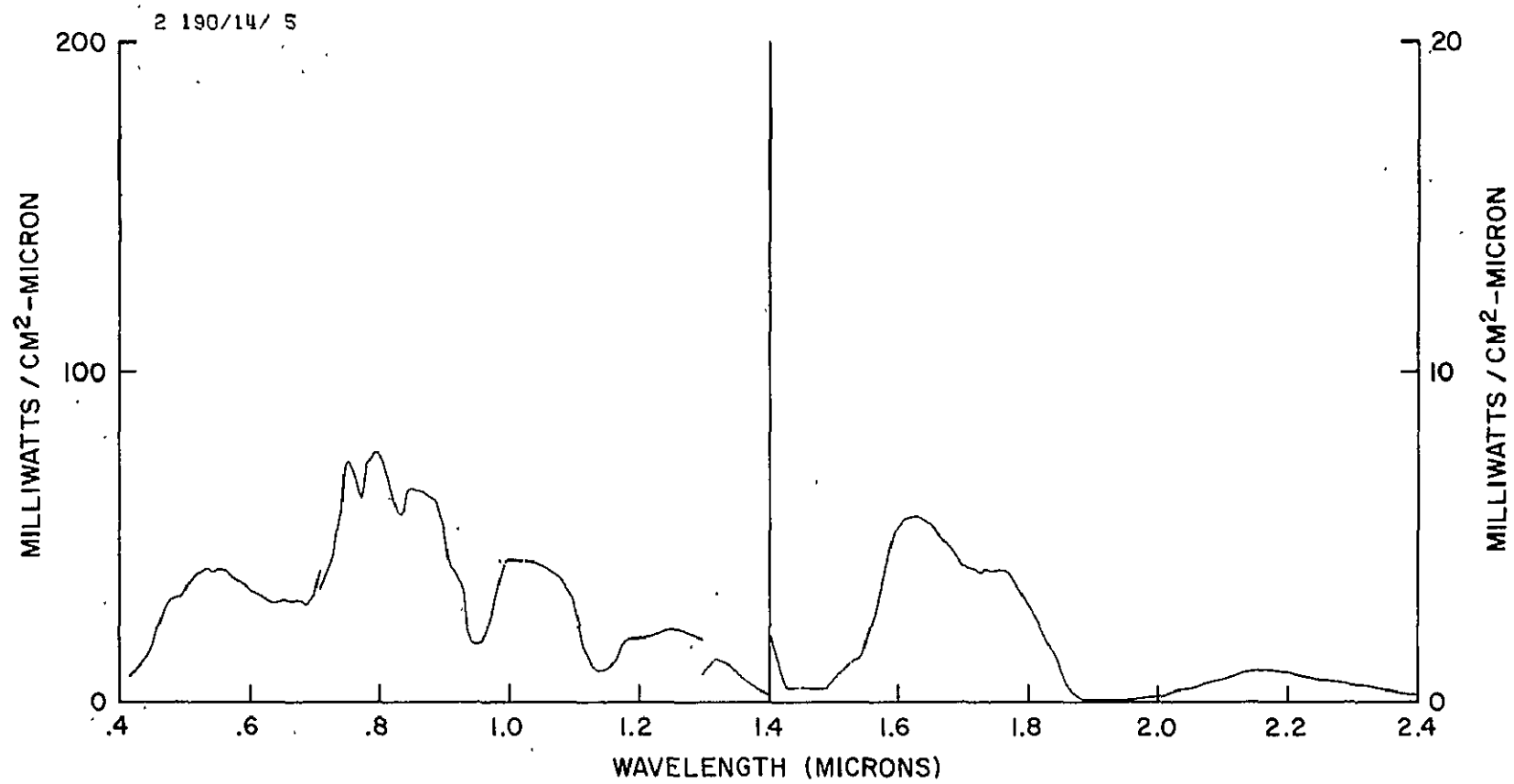


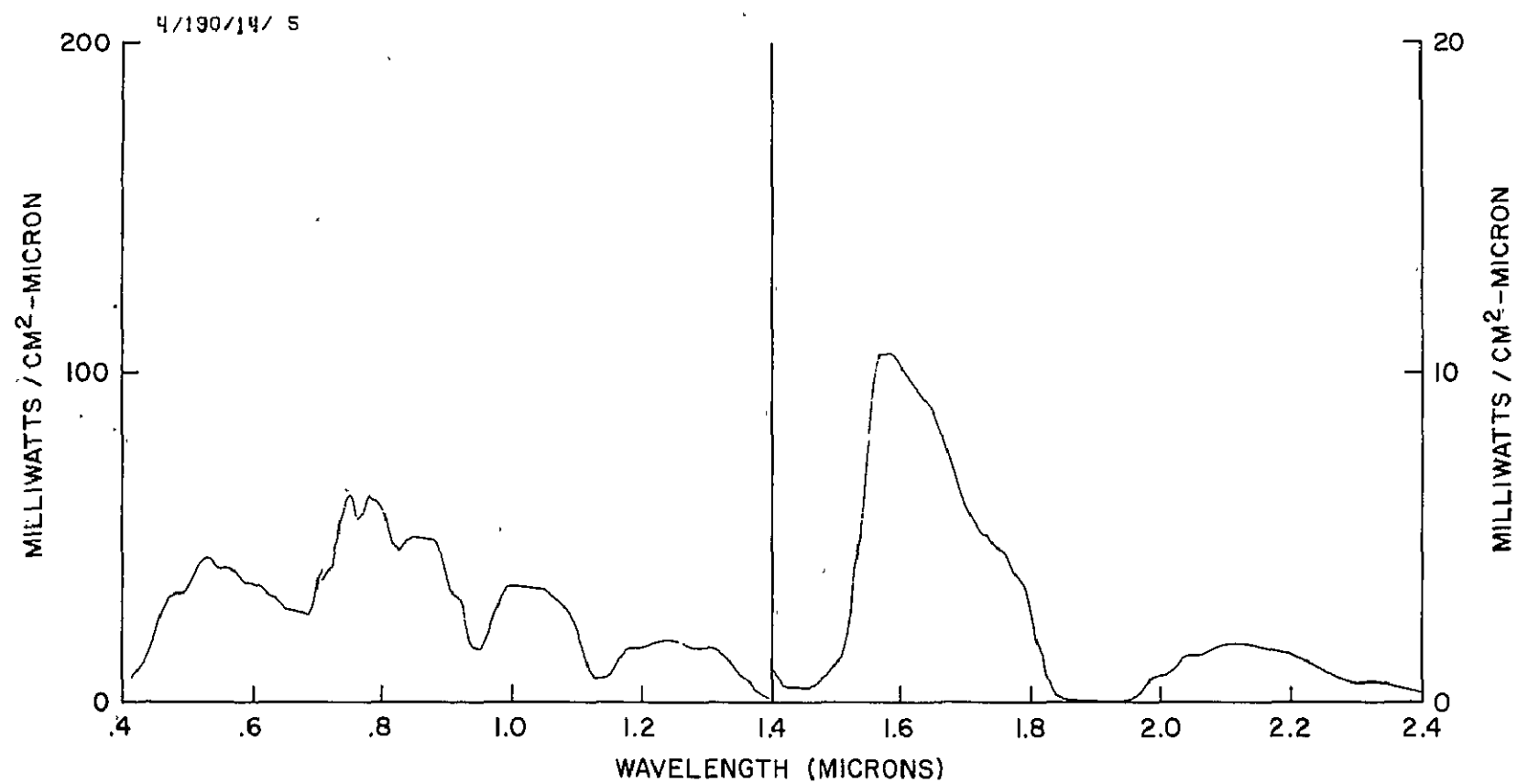


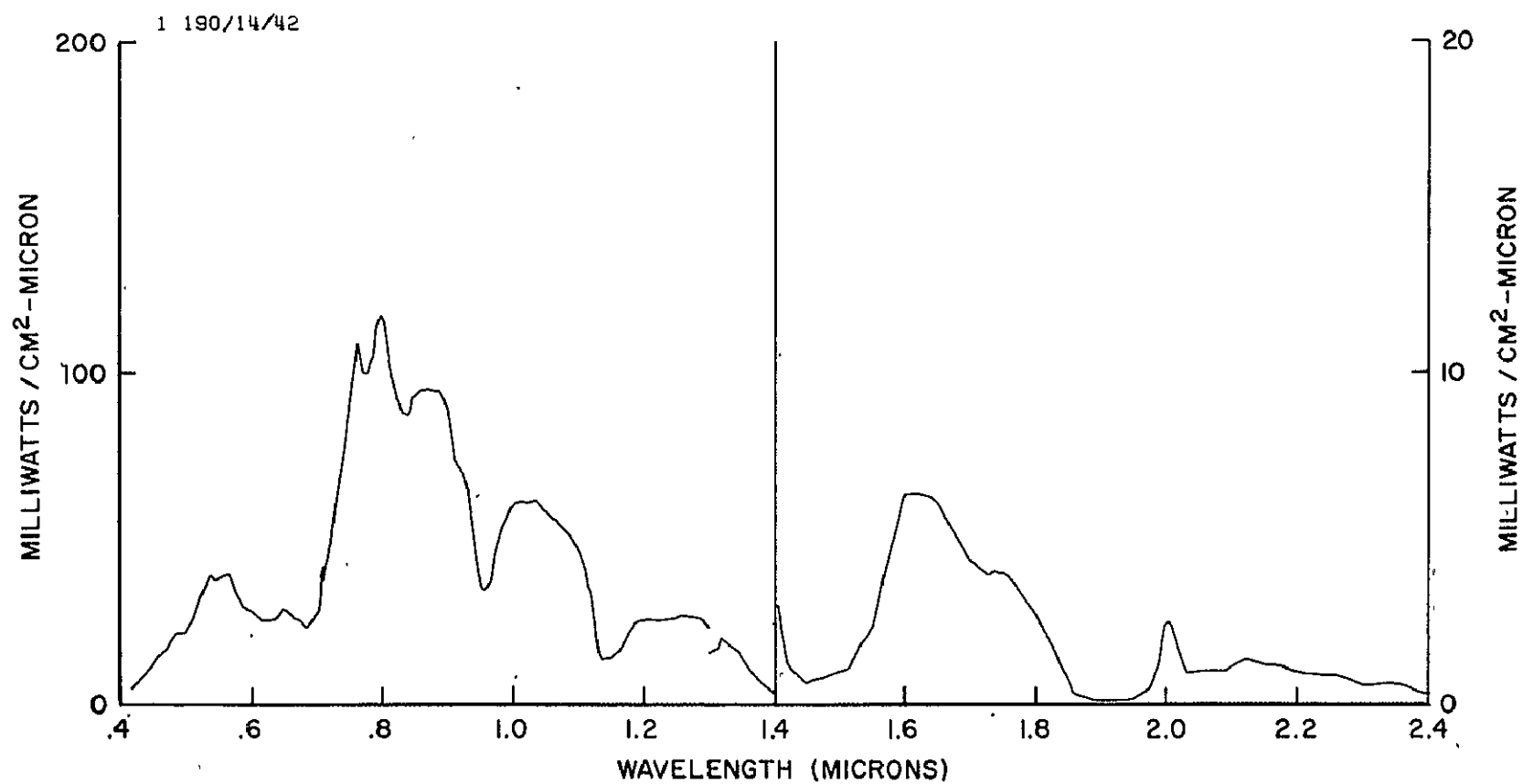




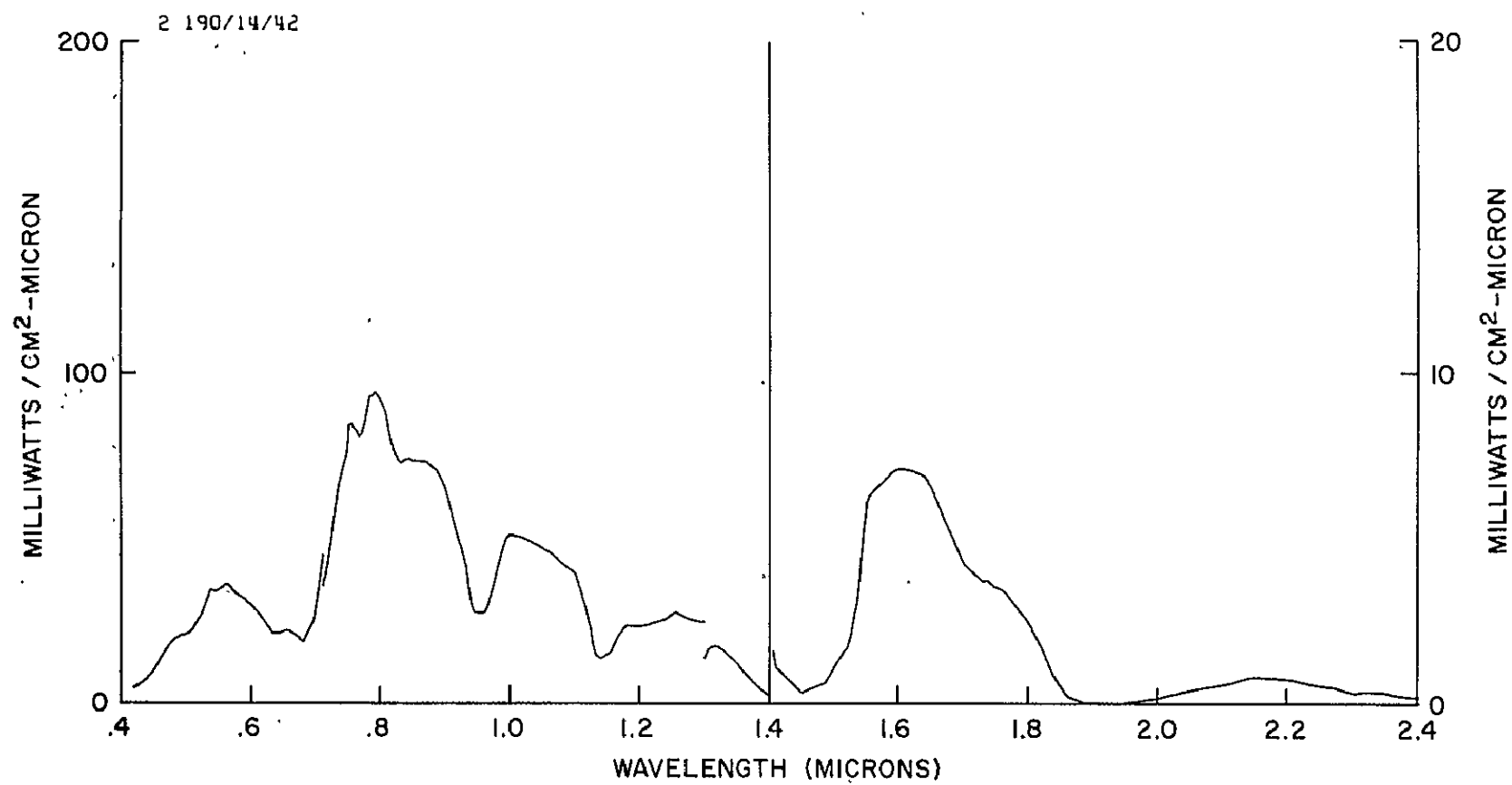


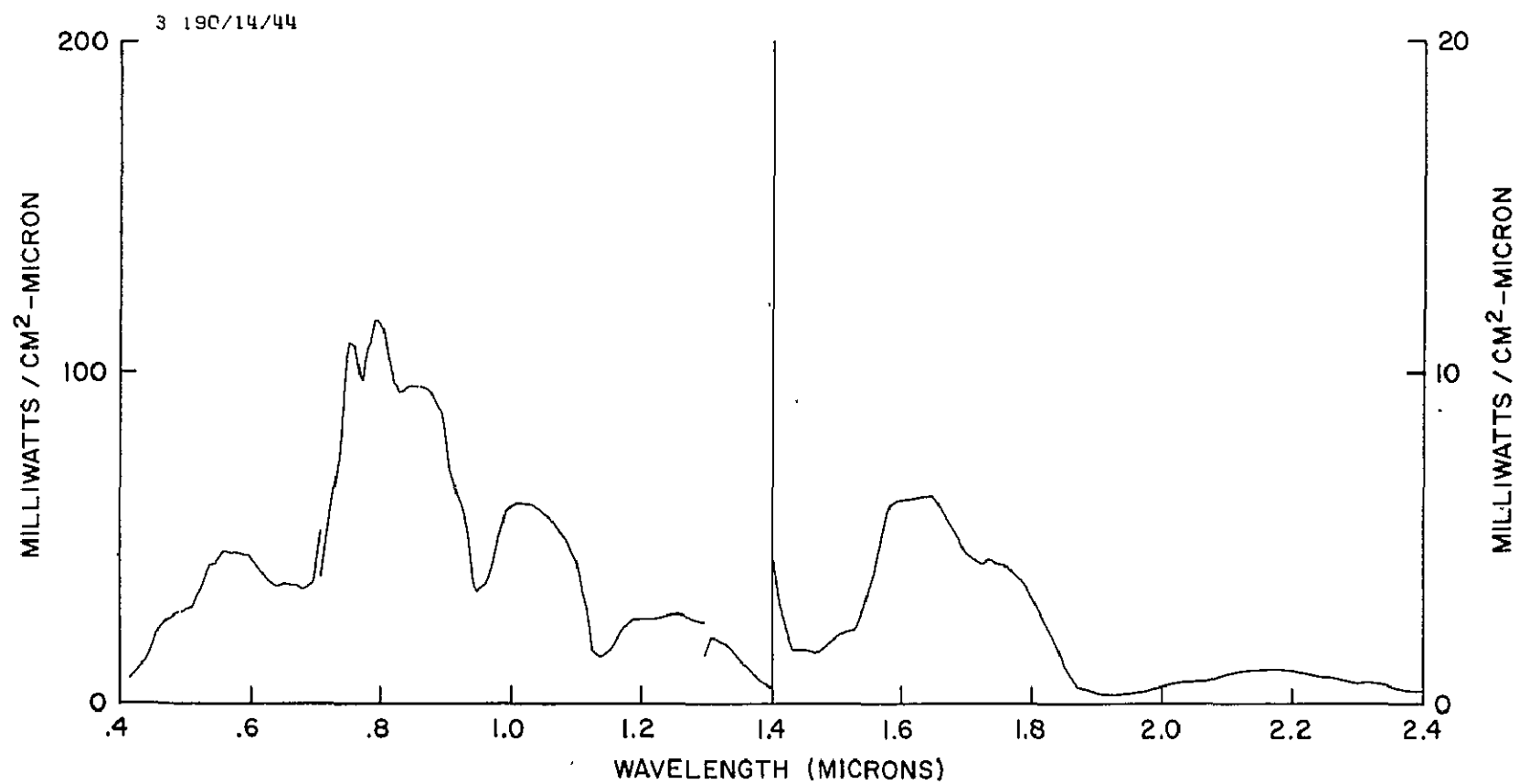


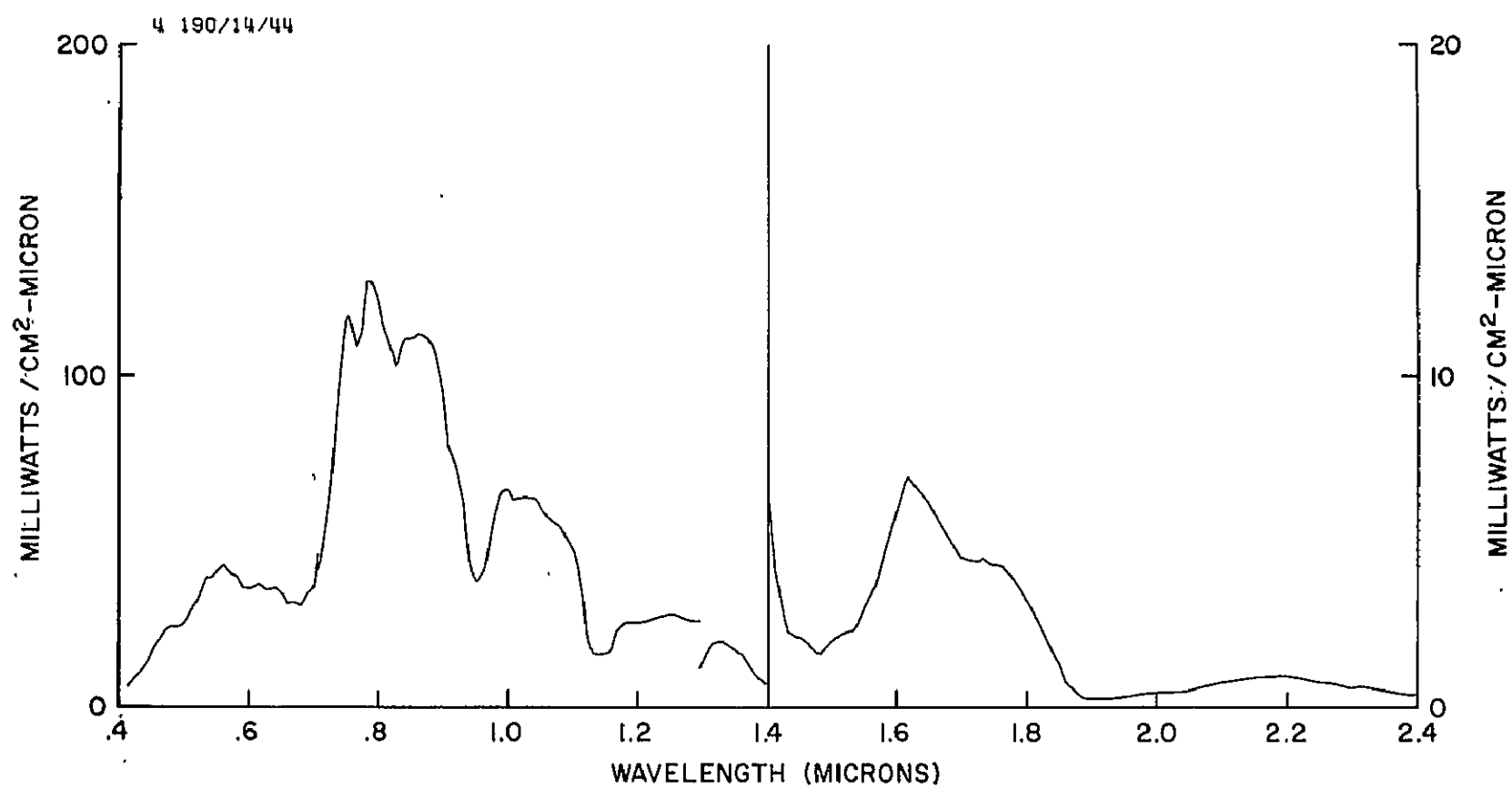


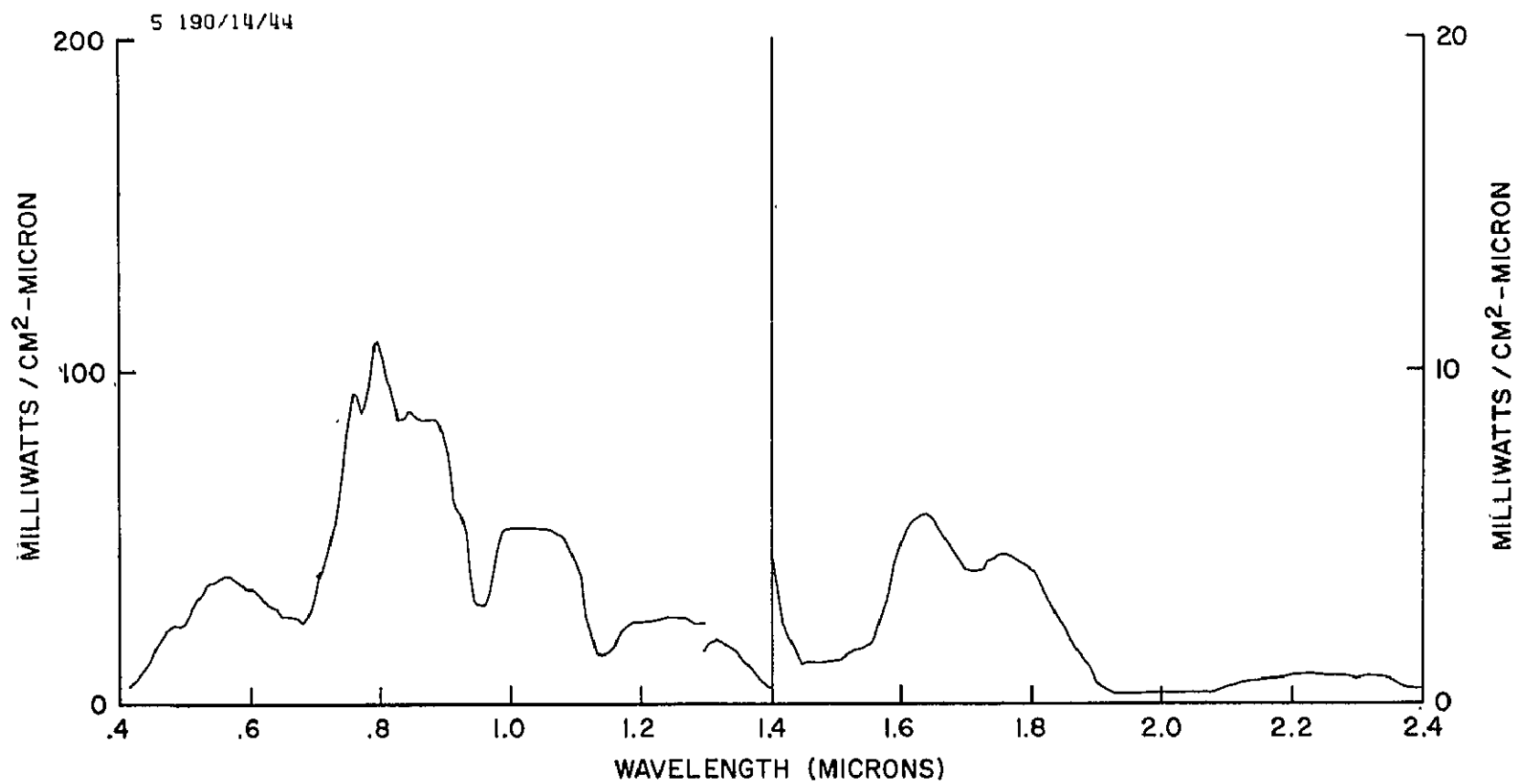




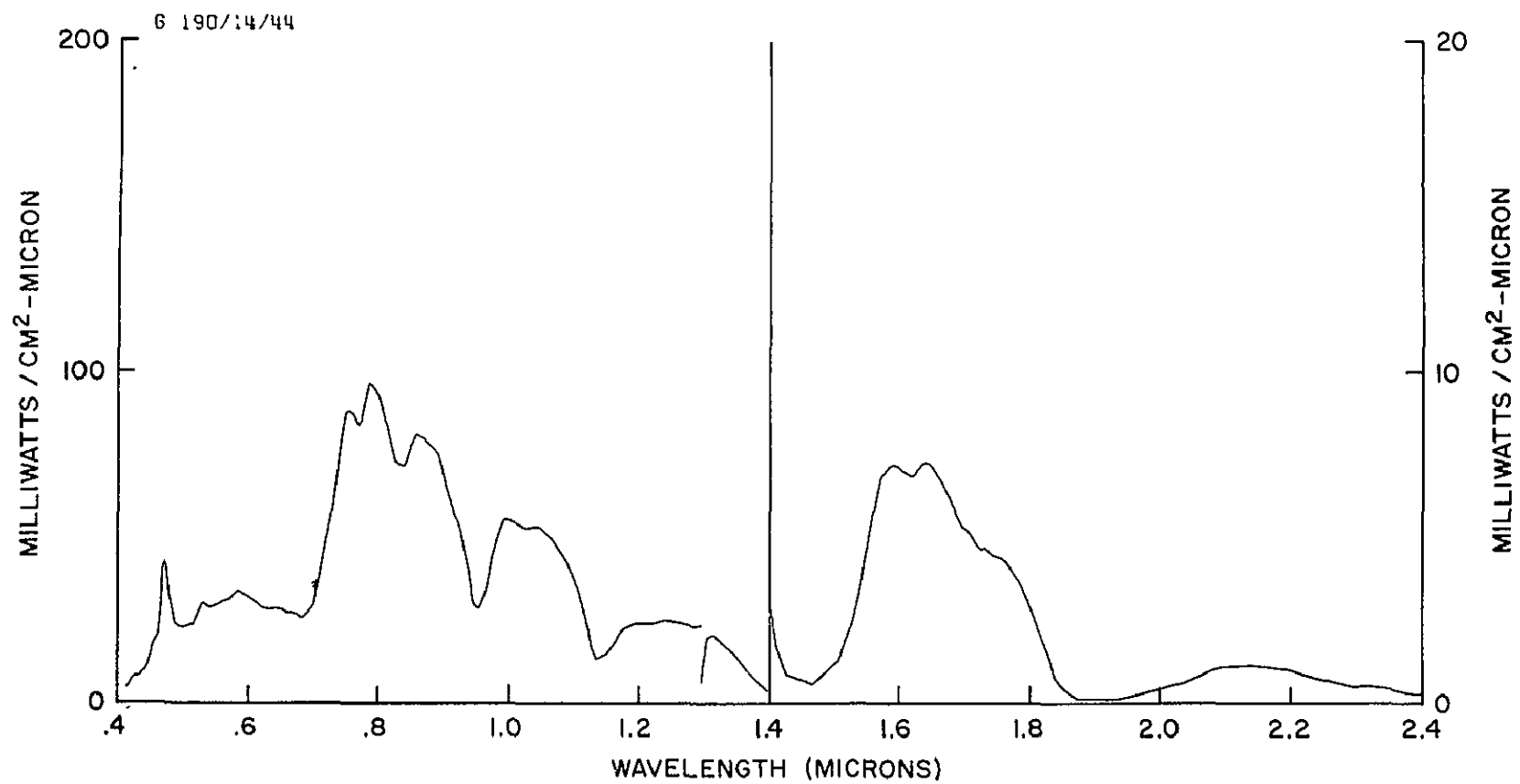








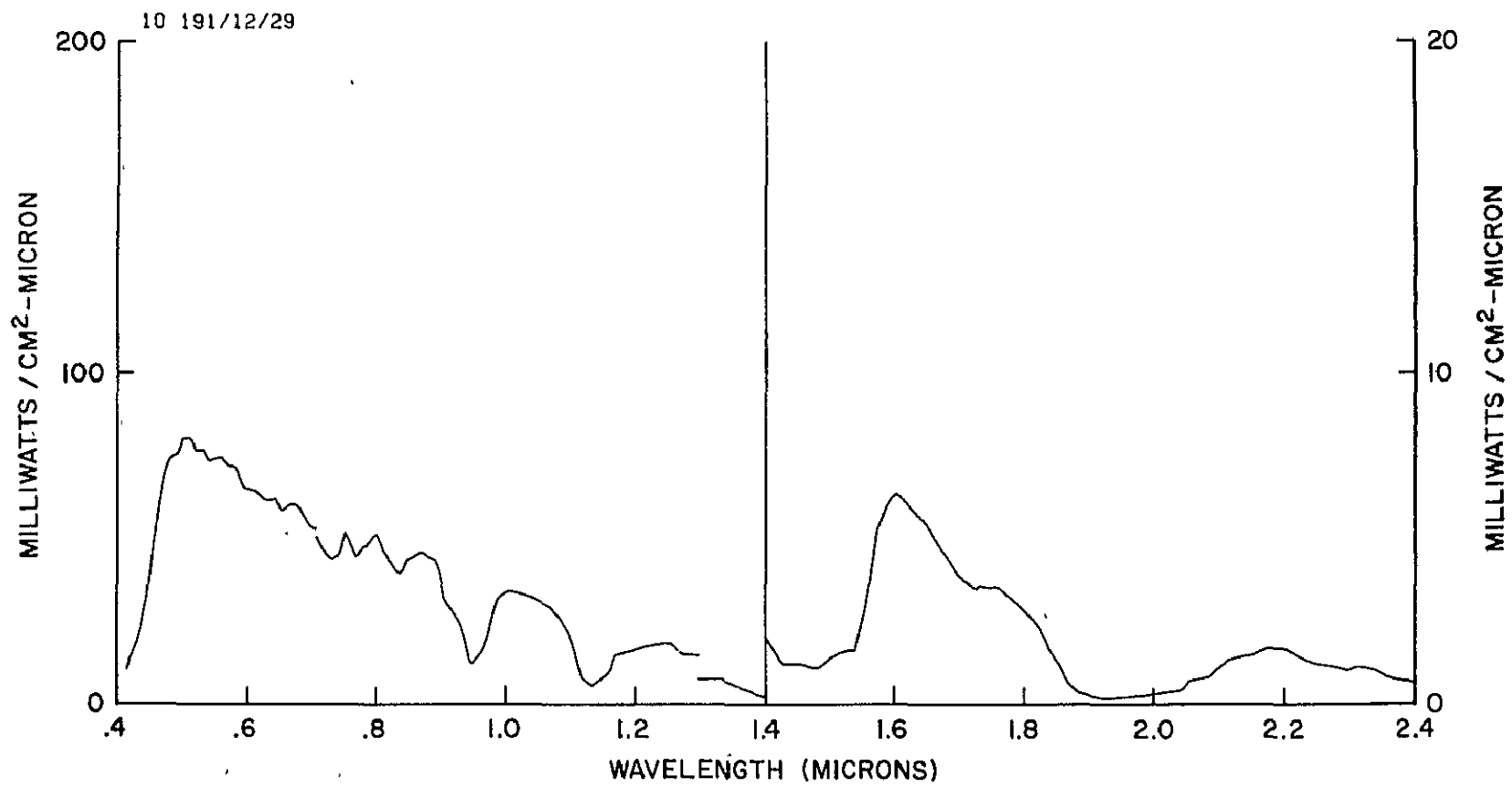
06

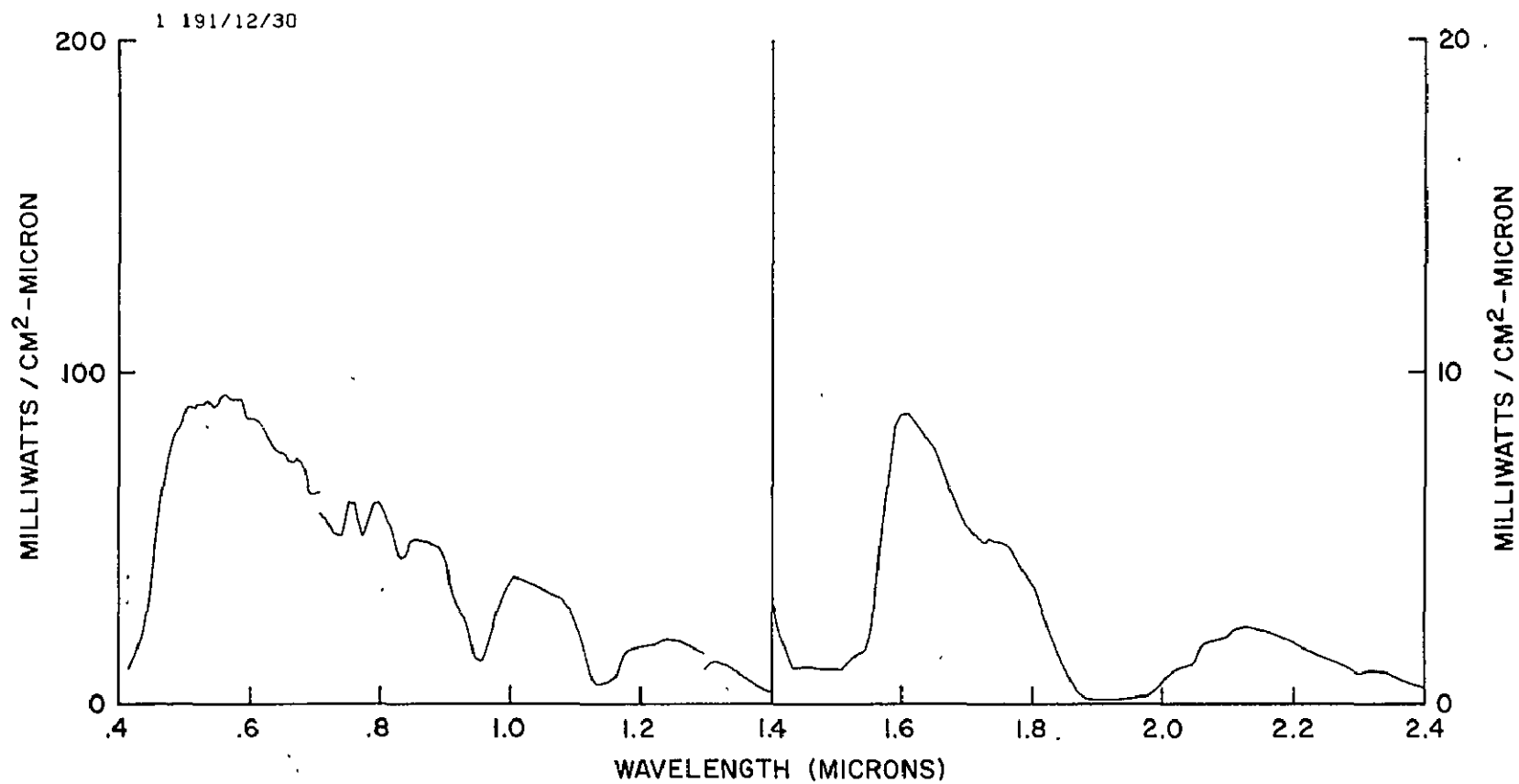


## IX. STRATUS CLOUD DECK

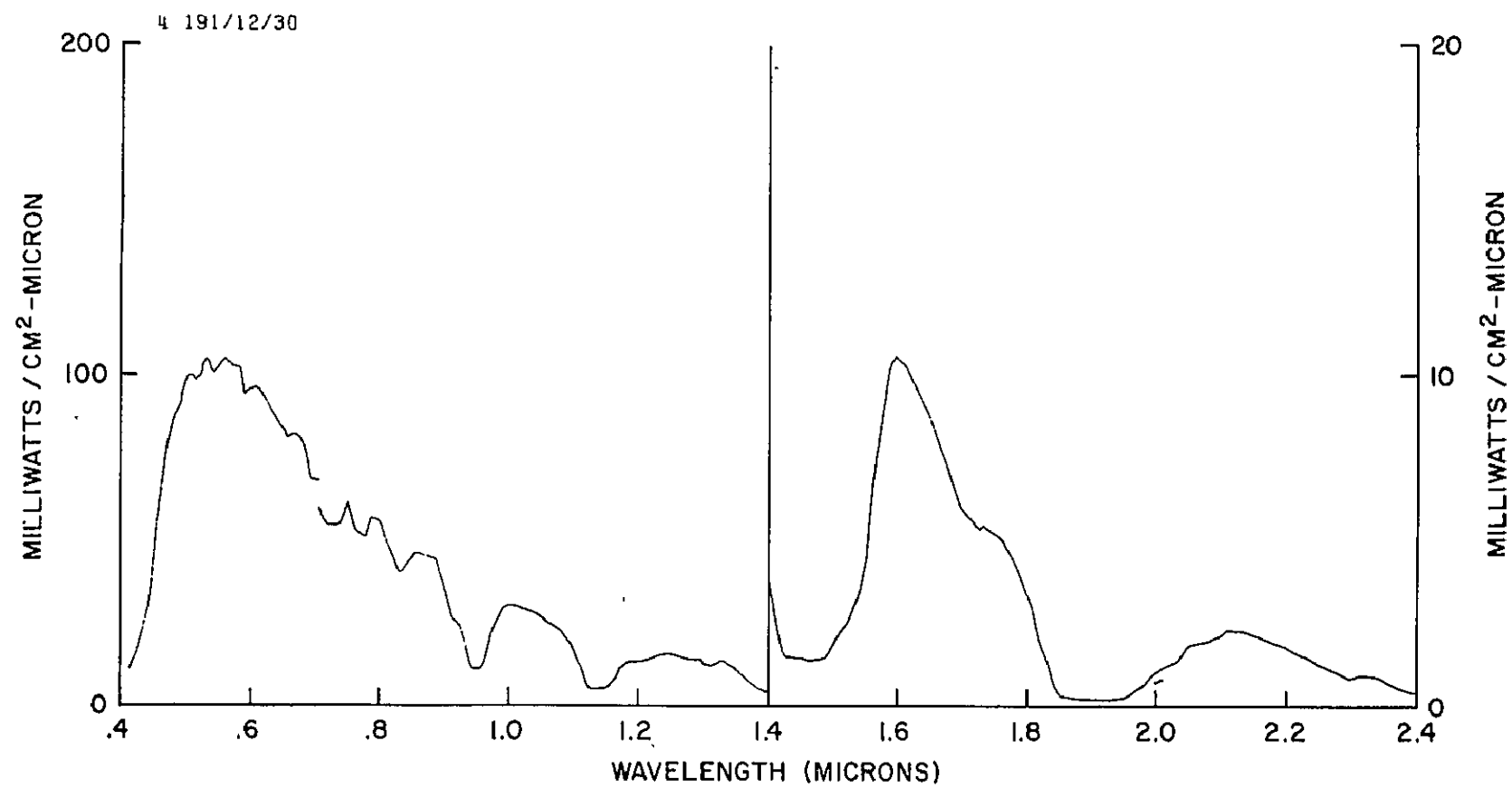
The following spectra were taken on July 10, 1970 (Julian Day 191) over a stratus cloud deck over Lake Michigan 75 miles north of Luddington, Michigan. The cloud deck top was at 1,500 ft. (0.46 km) and the aircraft altitude was 9,500 ft. (2.90 km) when the spectra were taken. The aircraft used was the NASA C47 of Lewis Research Center.

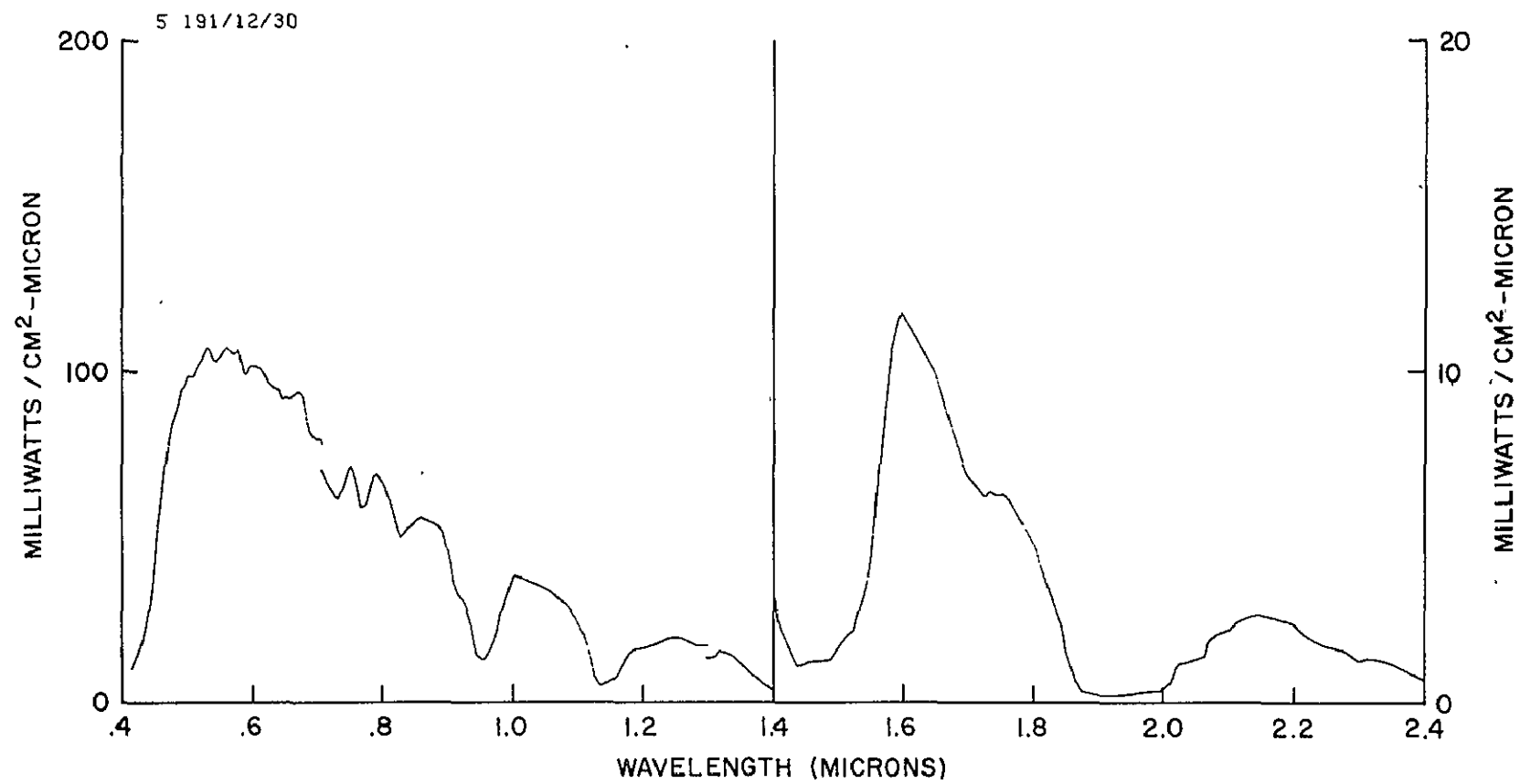
The sky overhead was clear and the spectra were taken between 12 hrs. 29 mins. and 12 hrs. 33 mins. Central Standard Time.

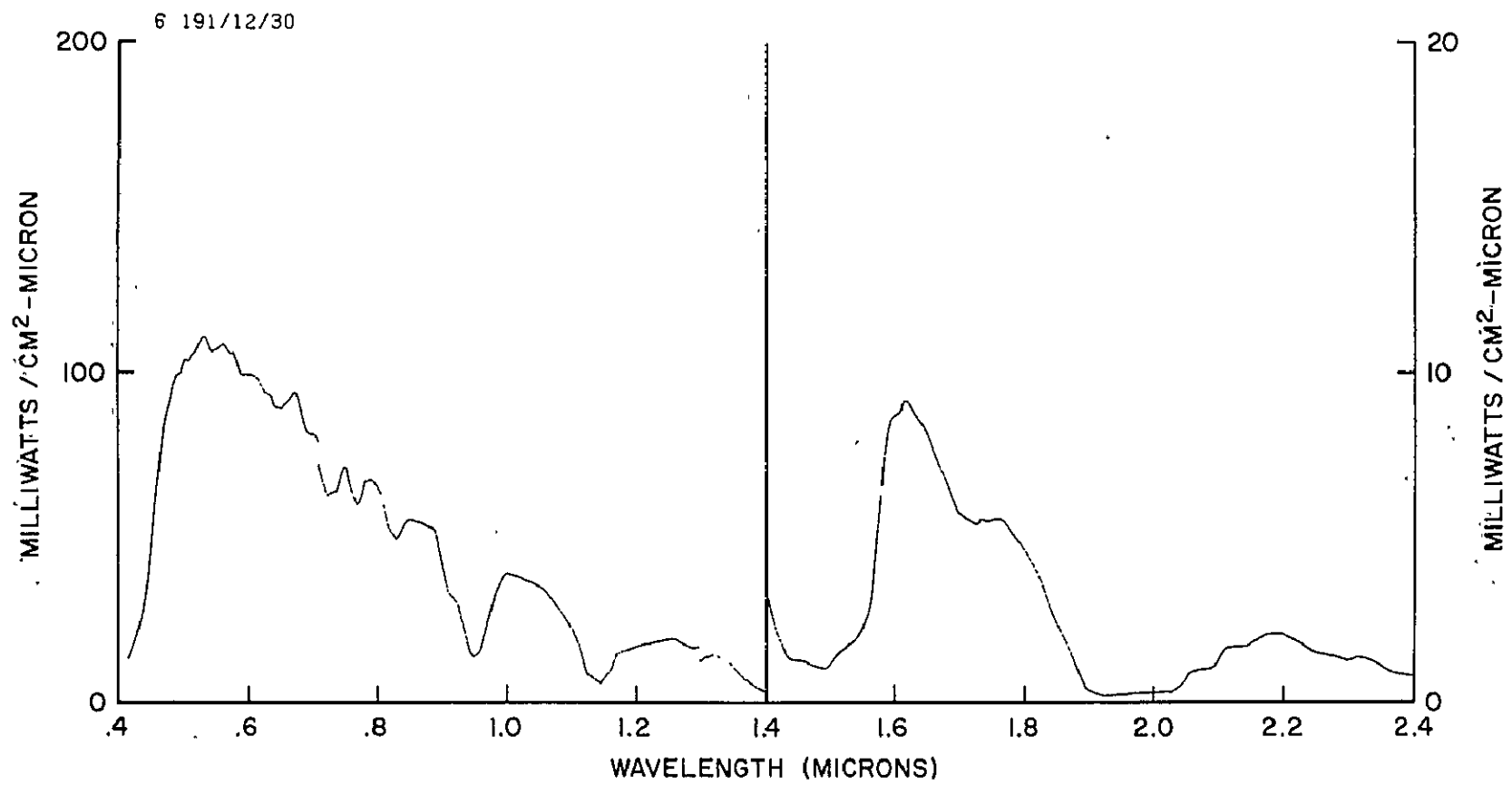


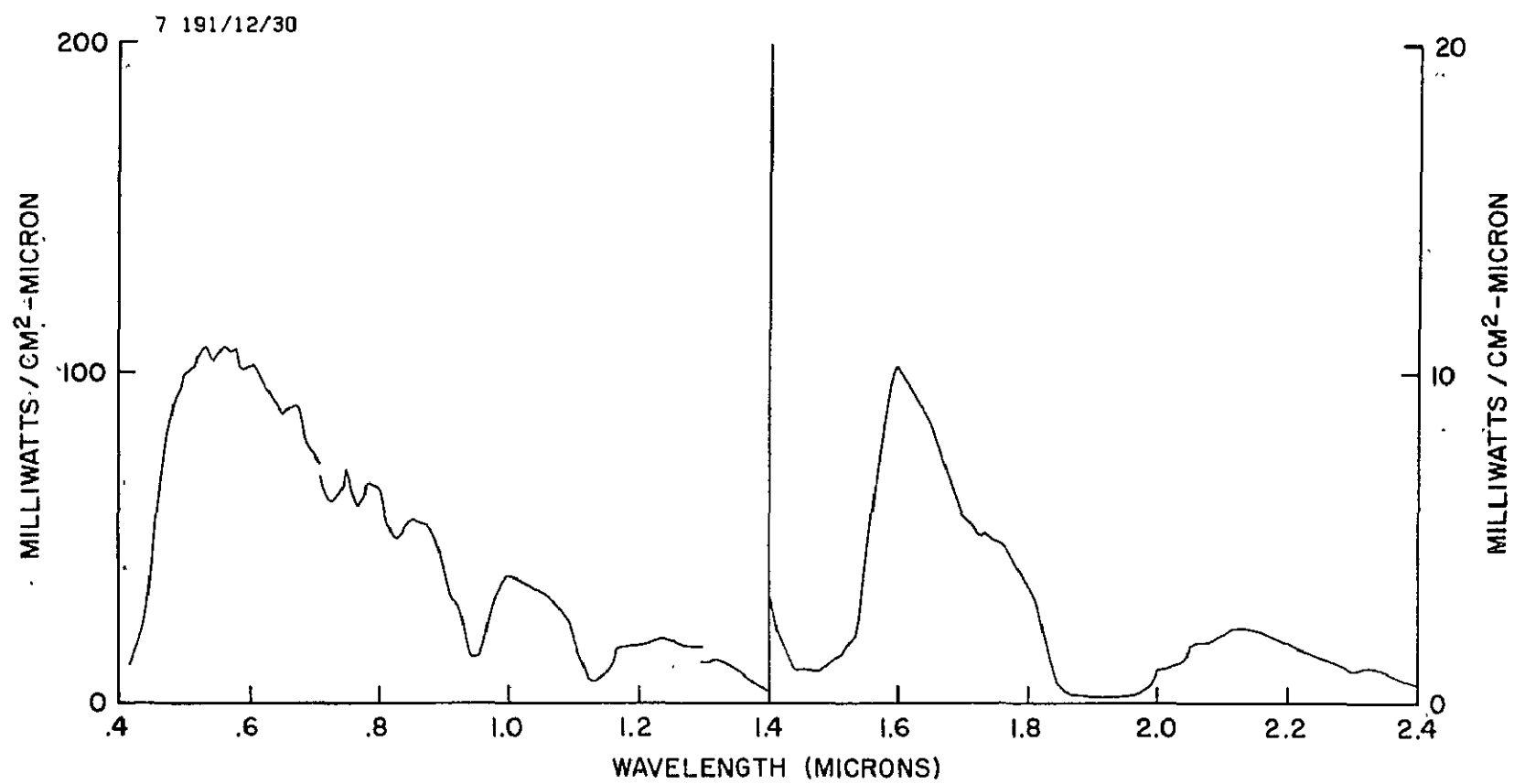


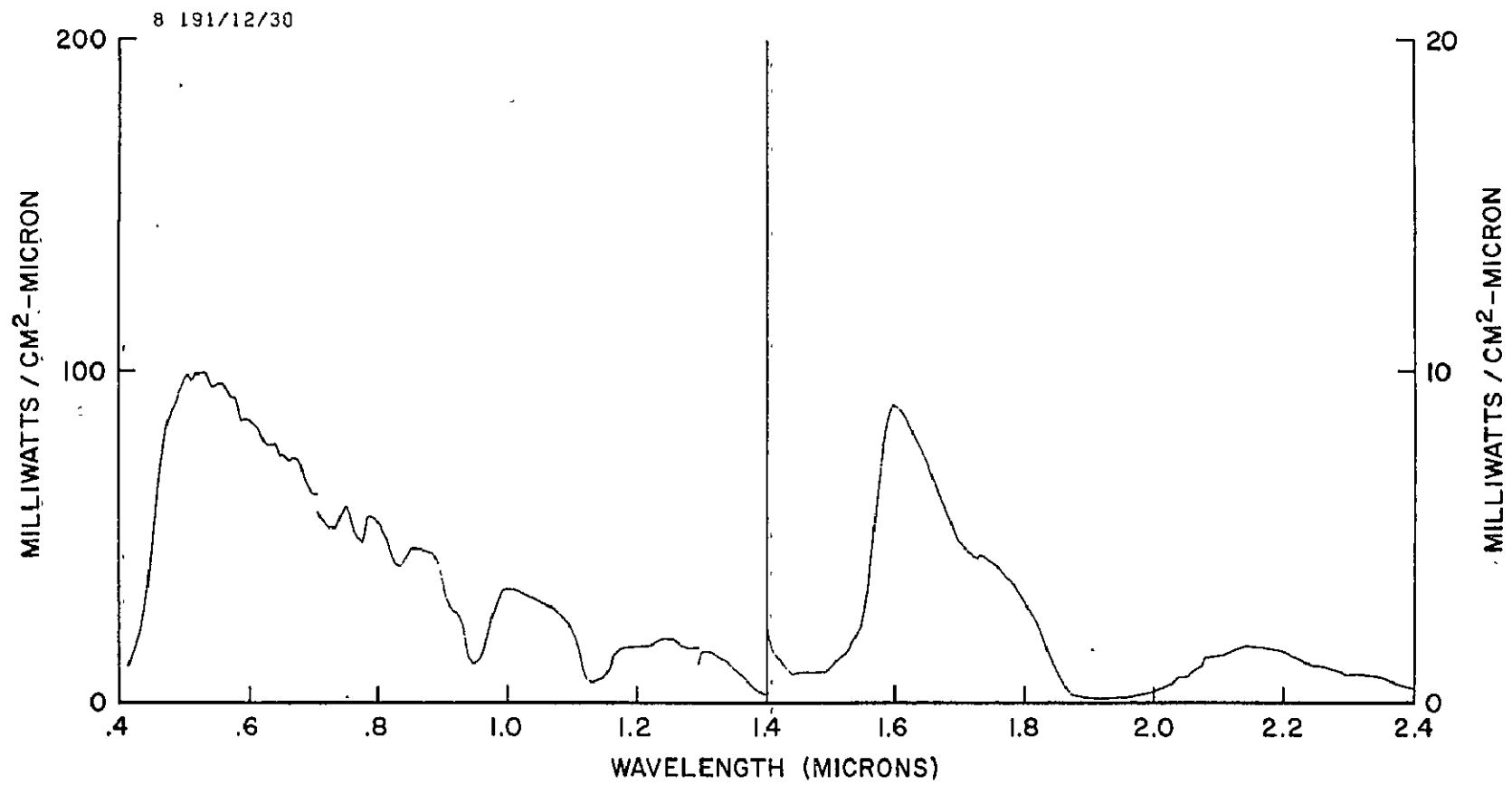


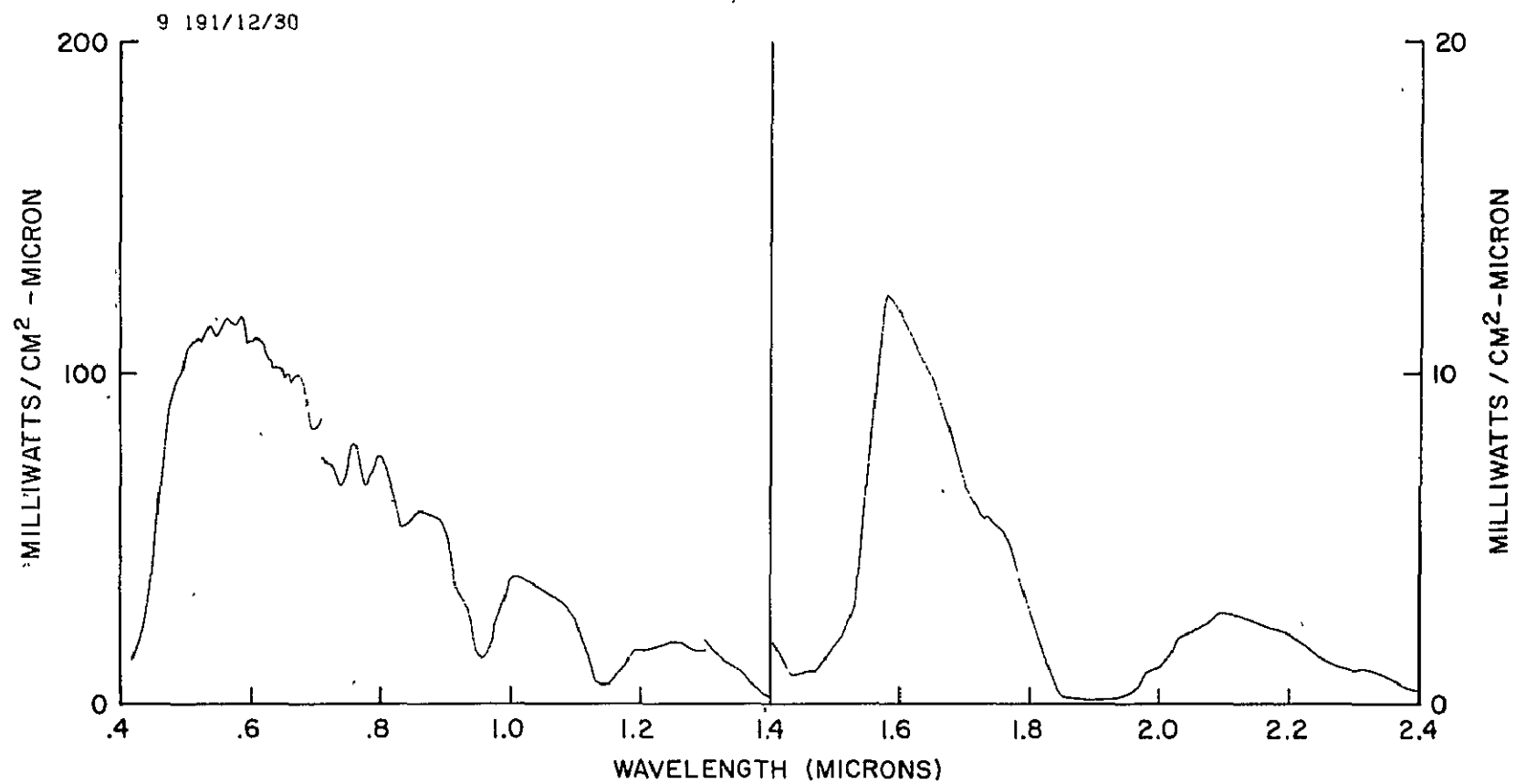


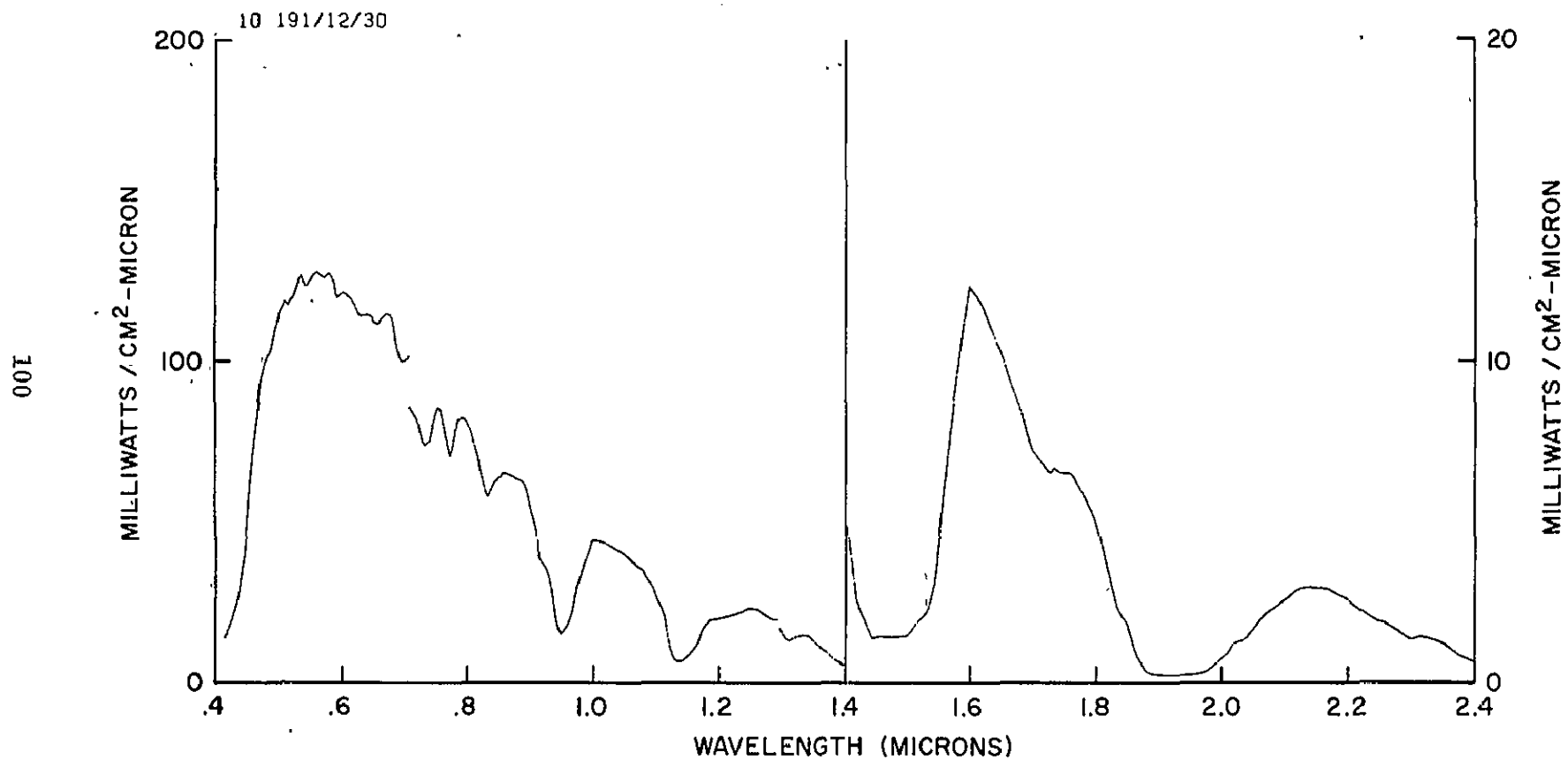


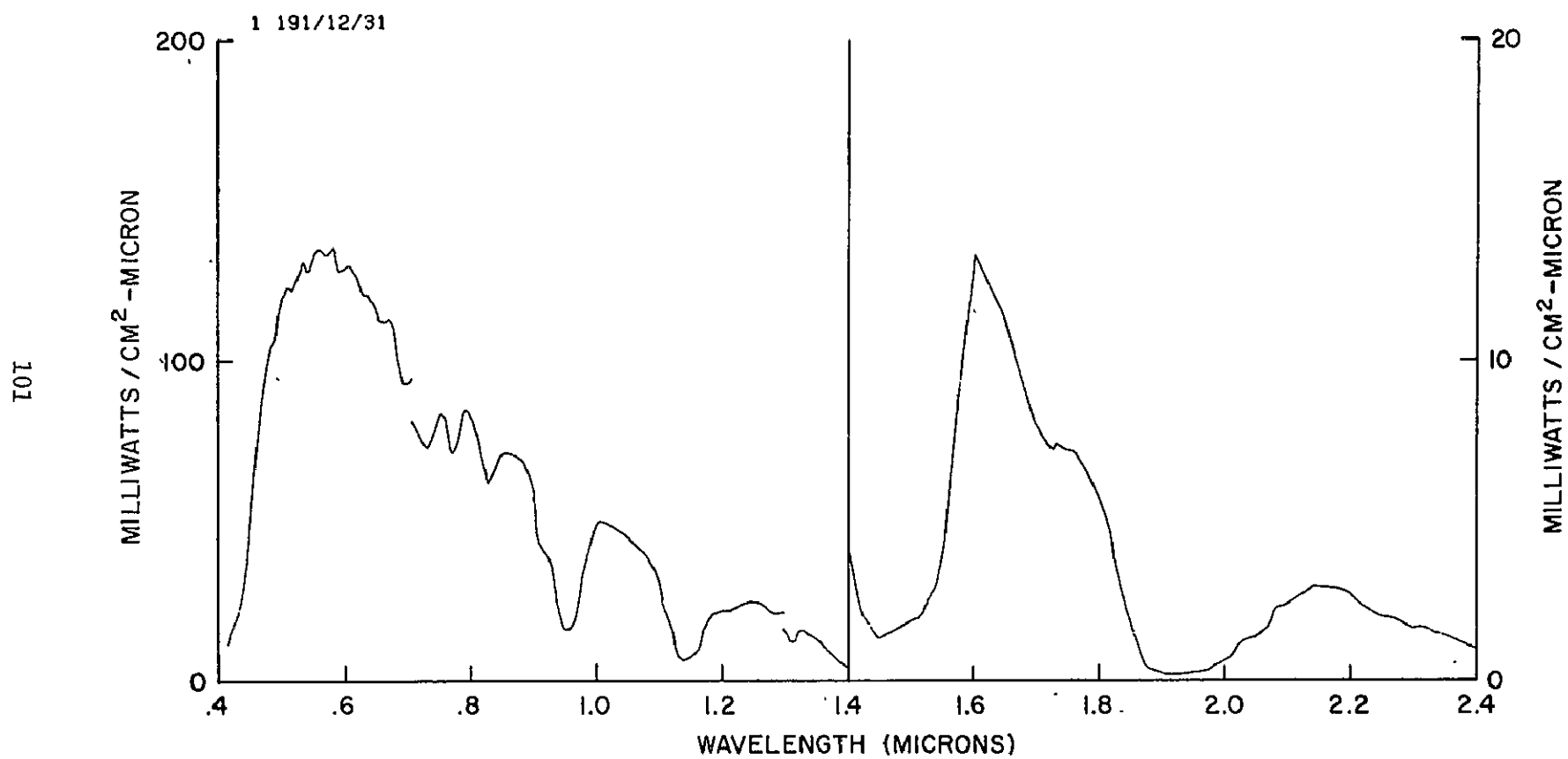




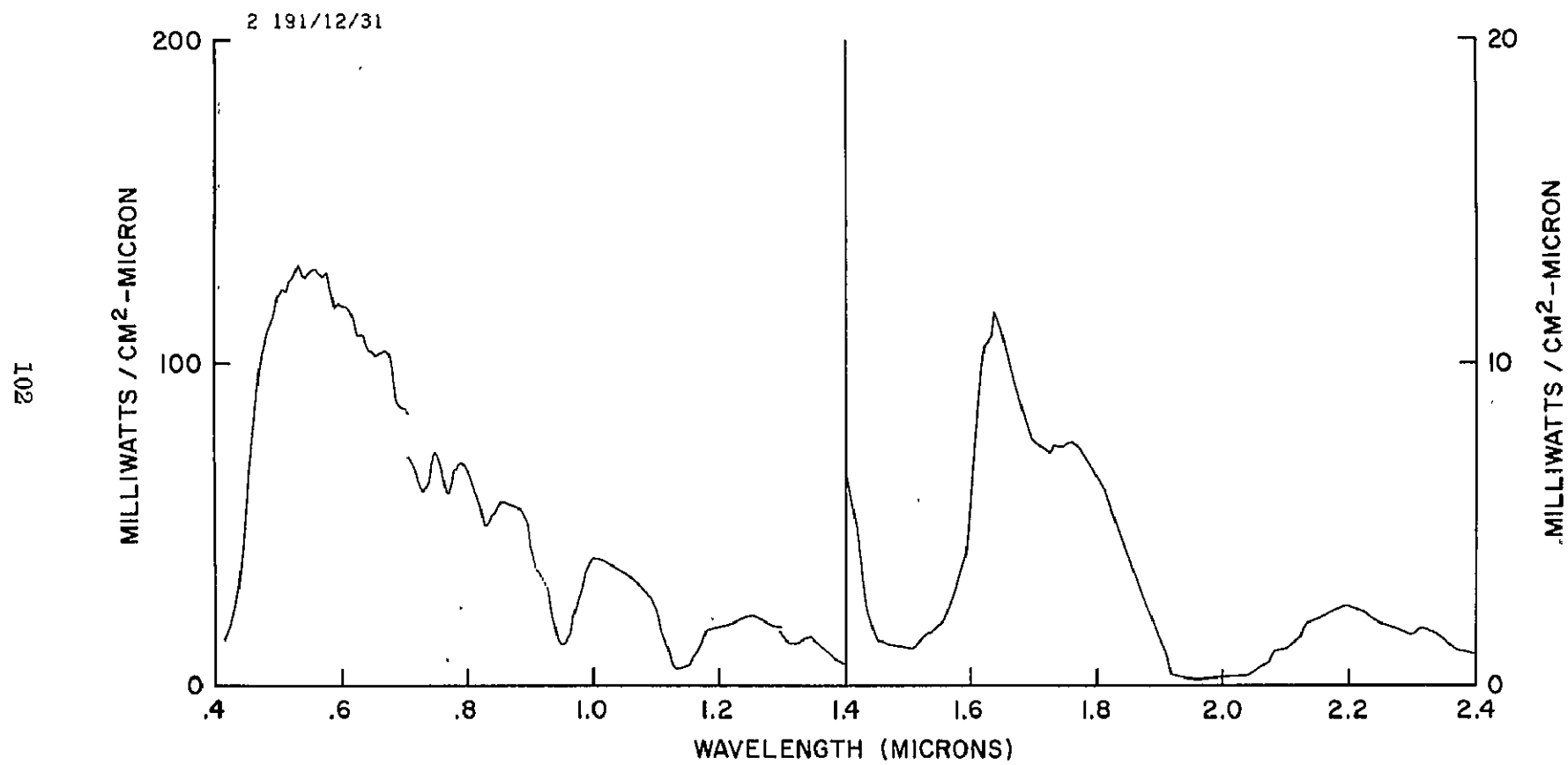


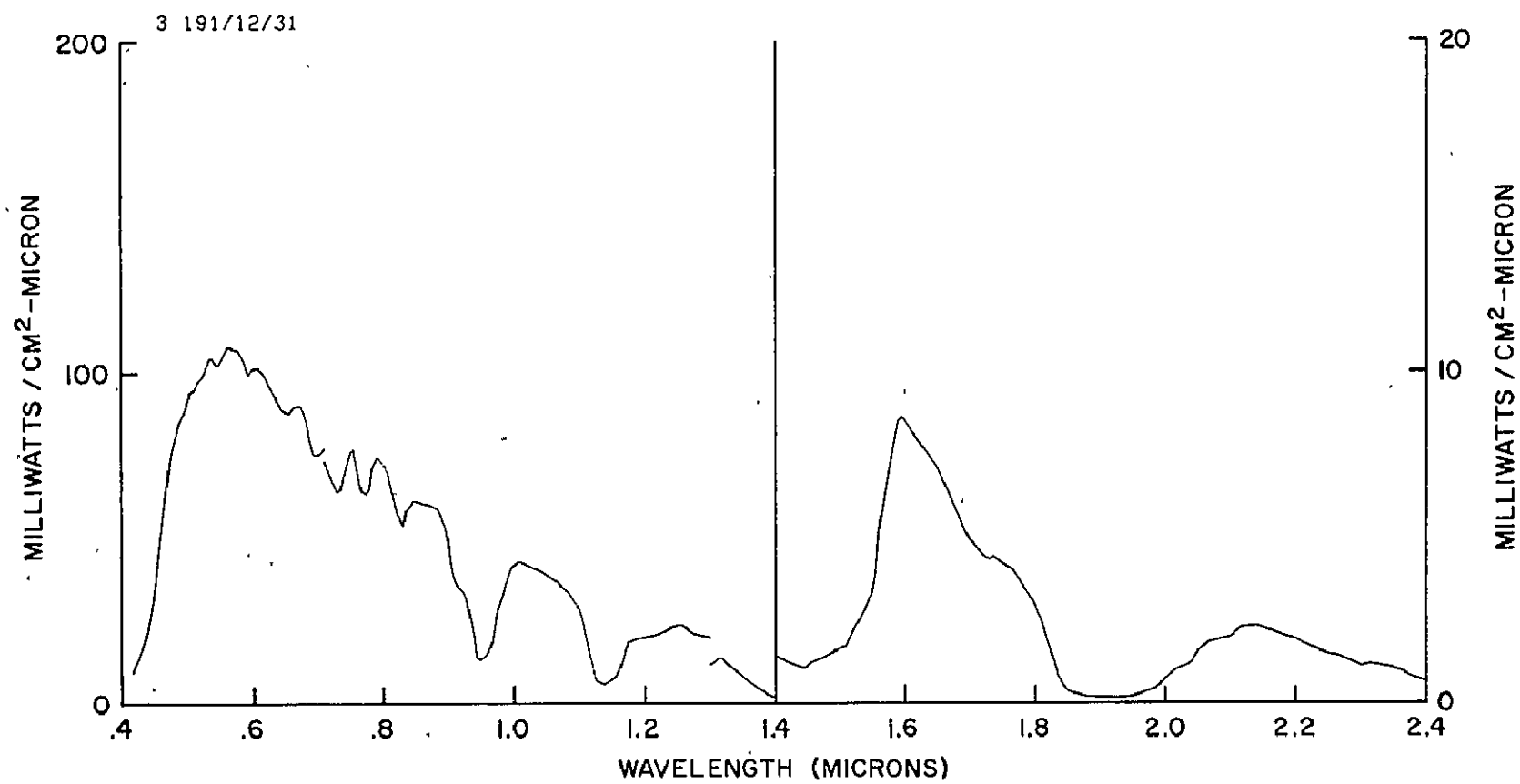




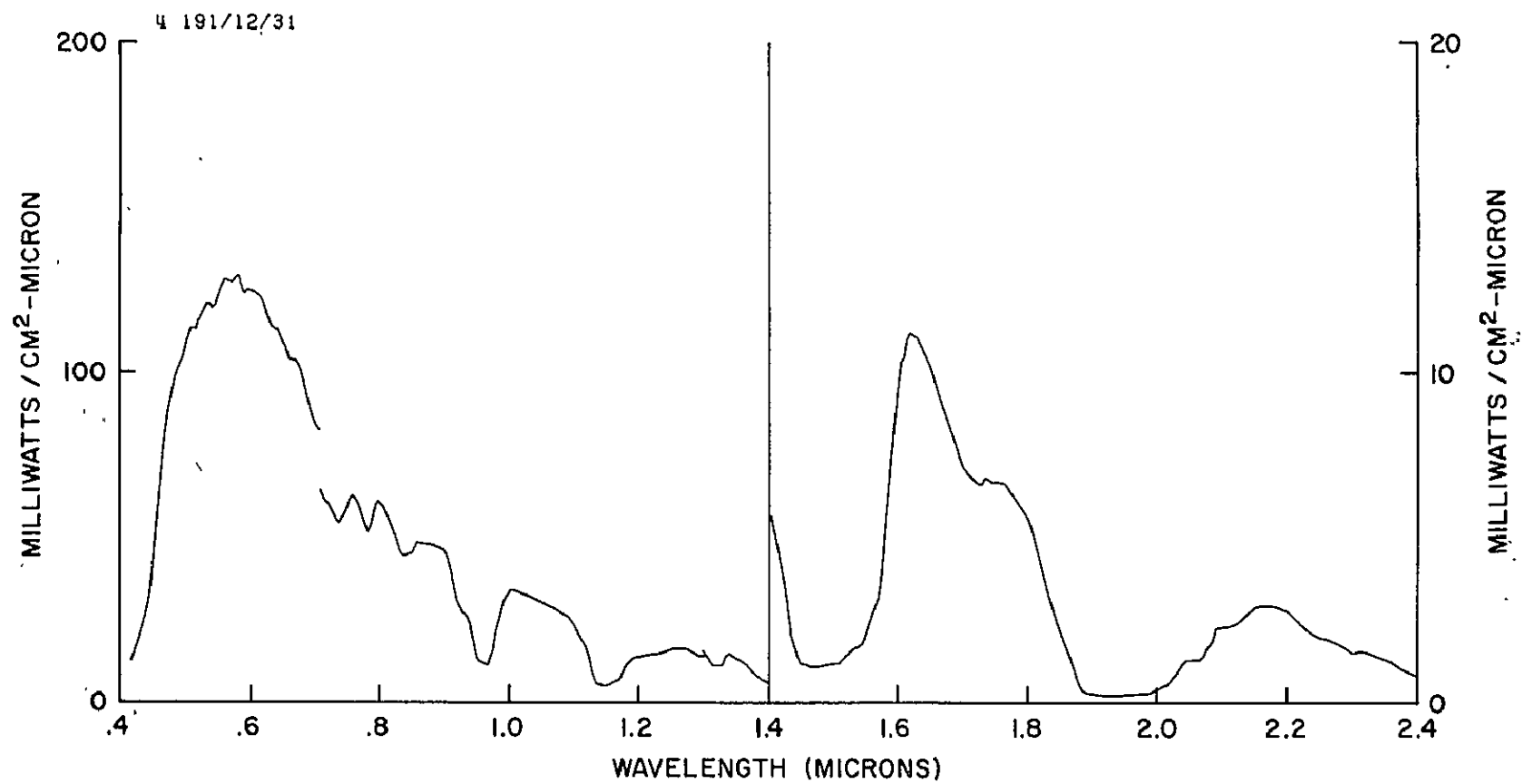


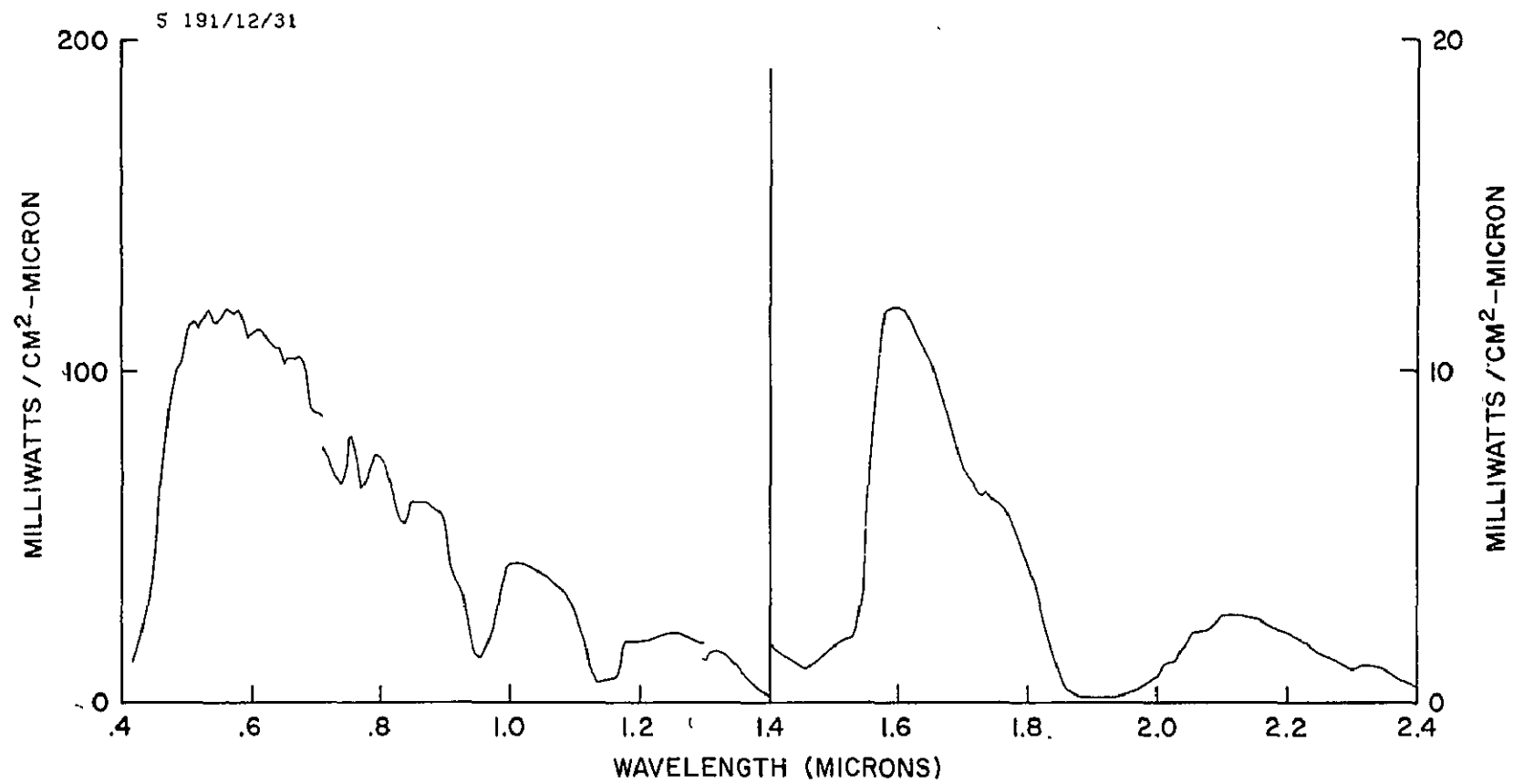


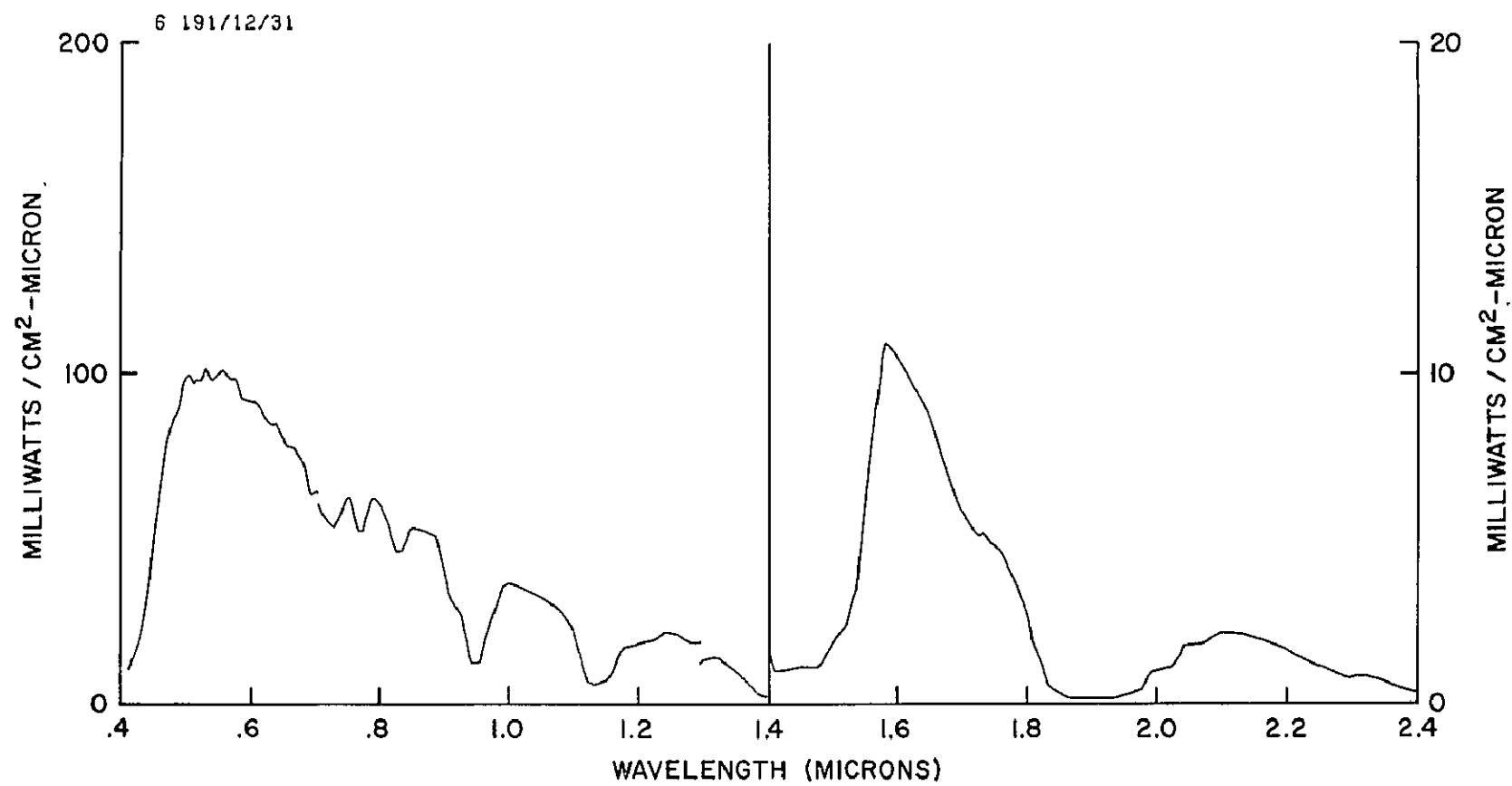




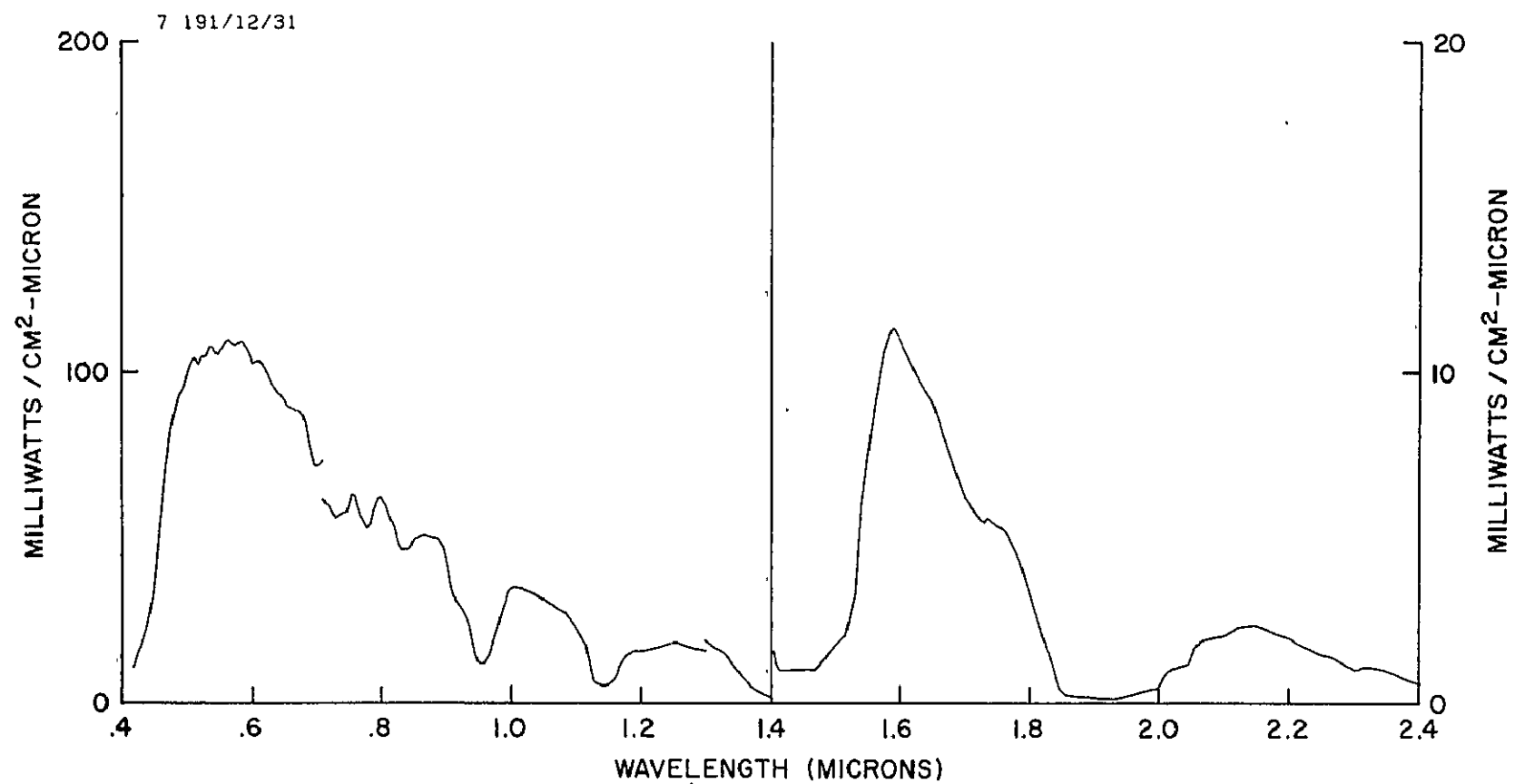
104

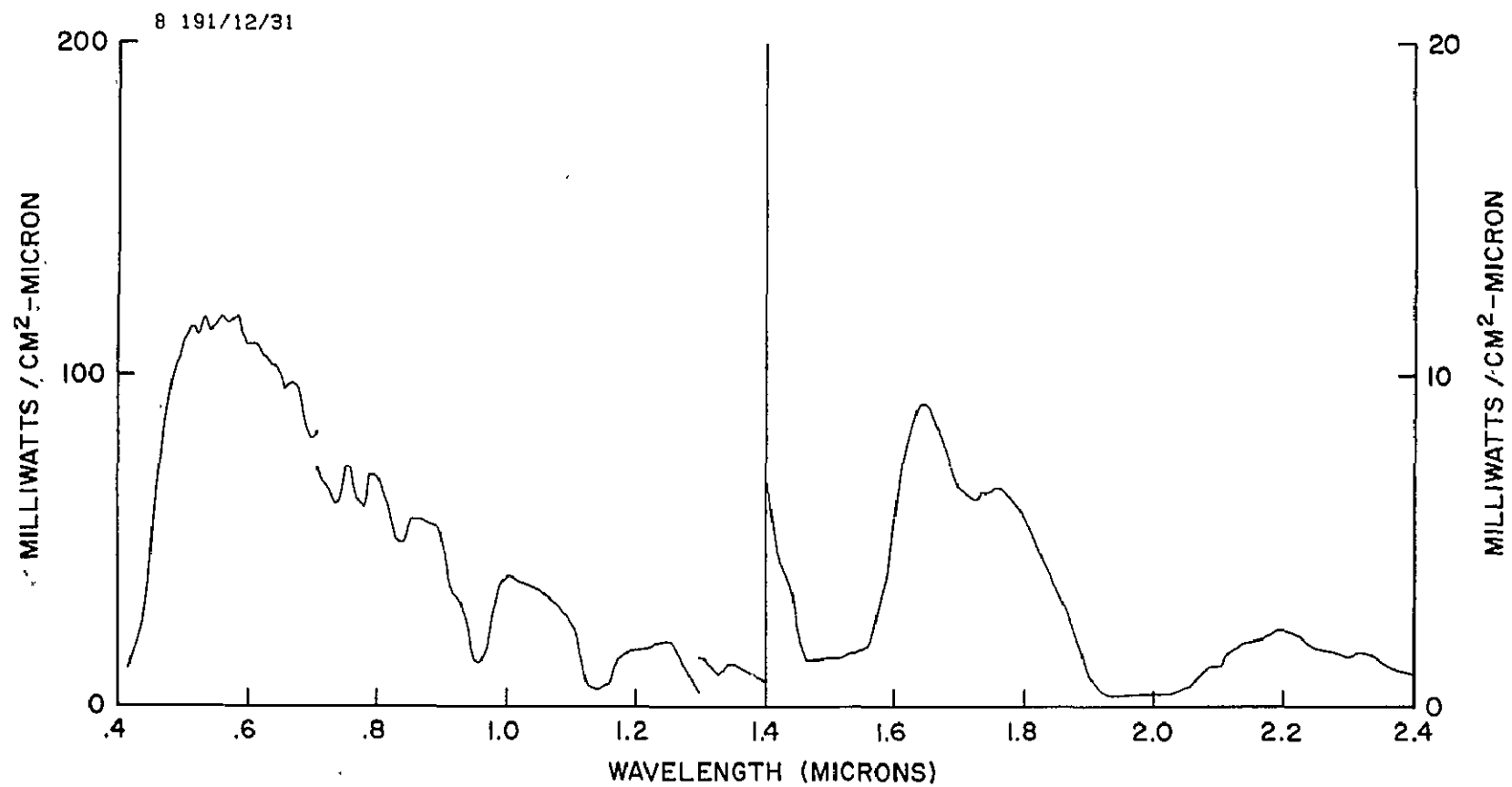




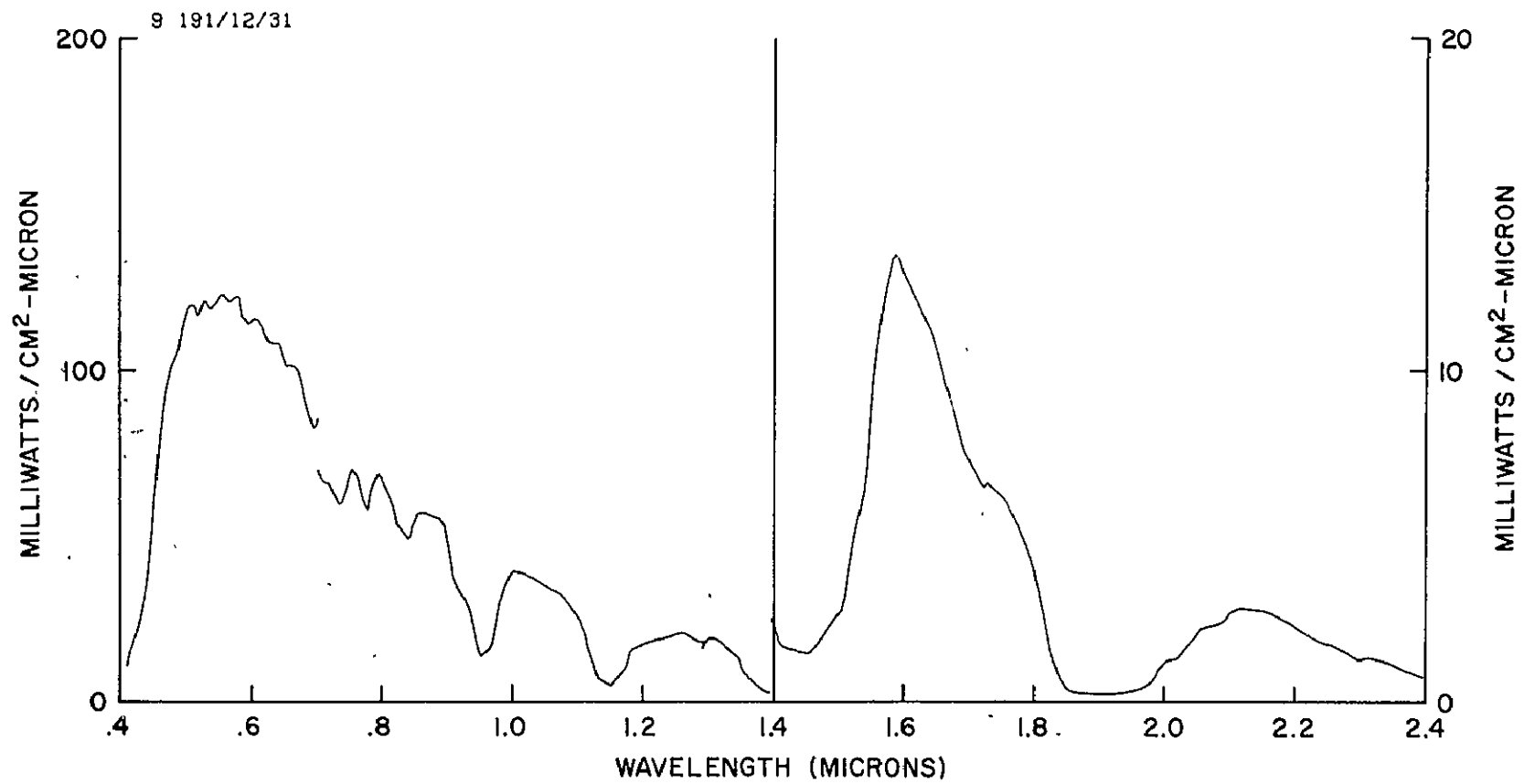


107

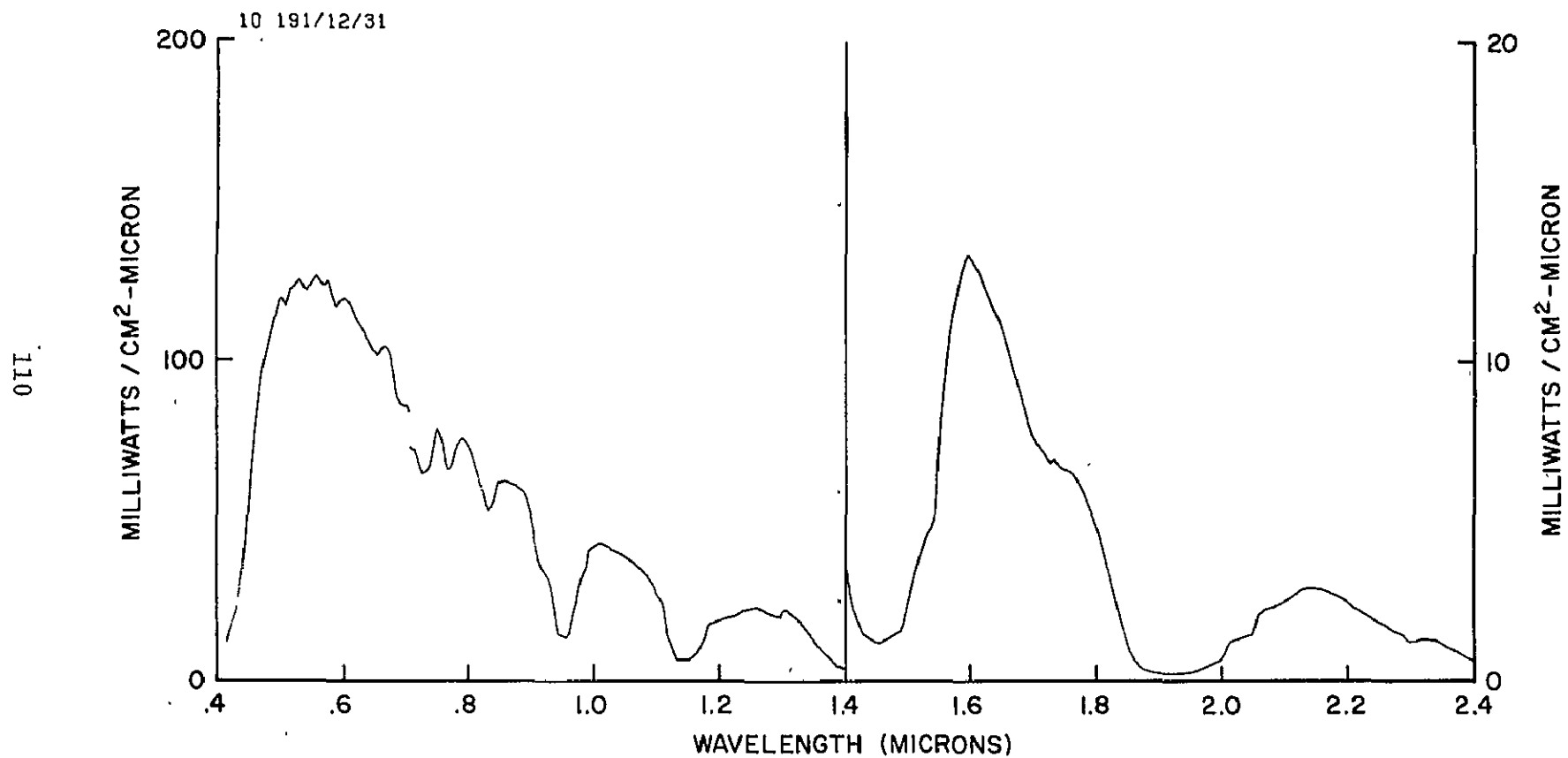


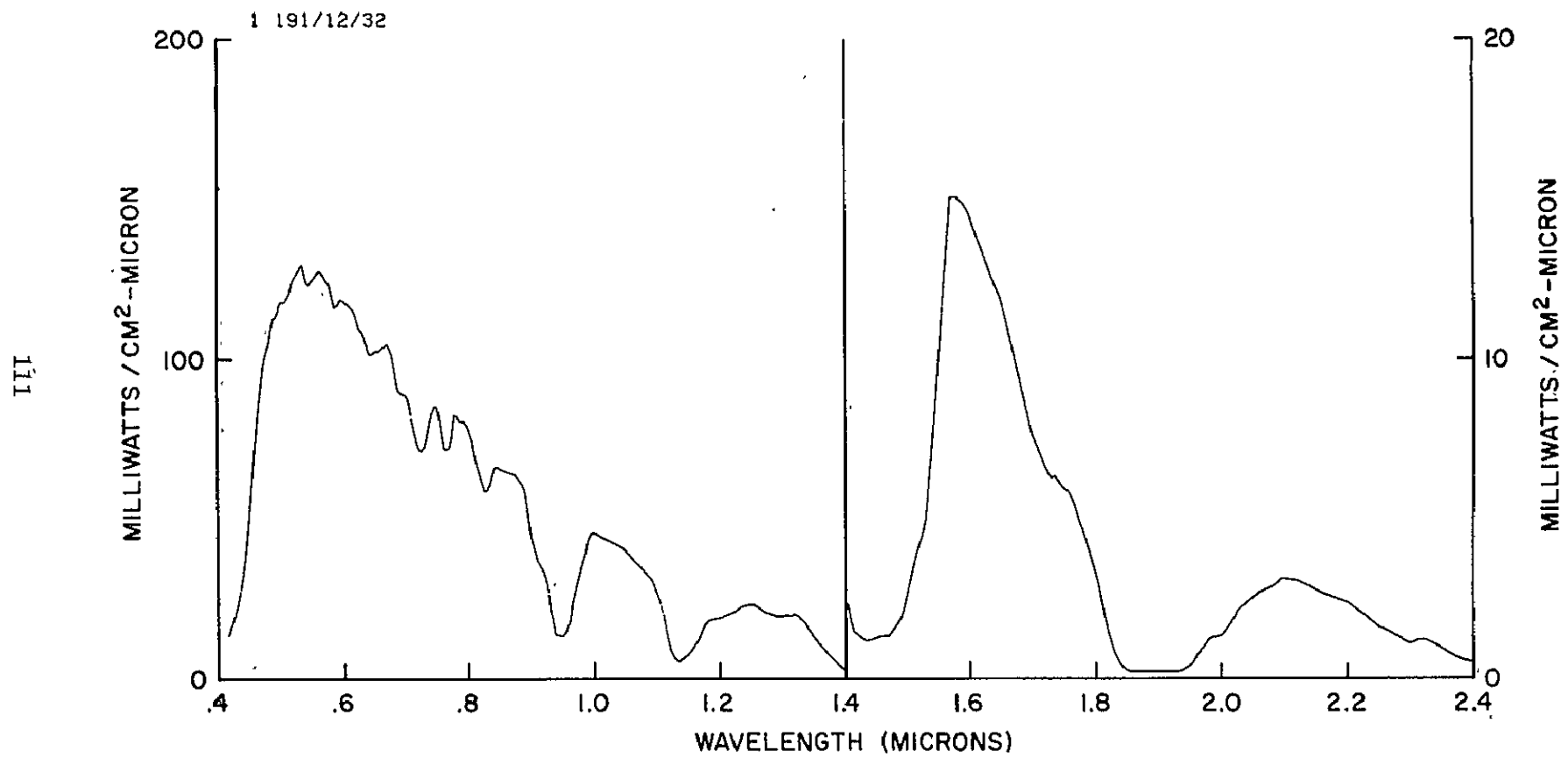


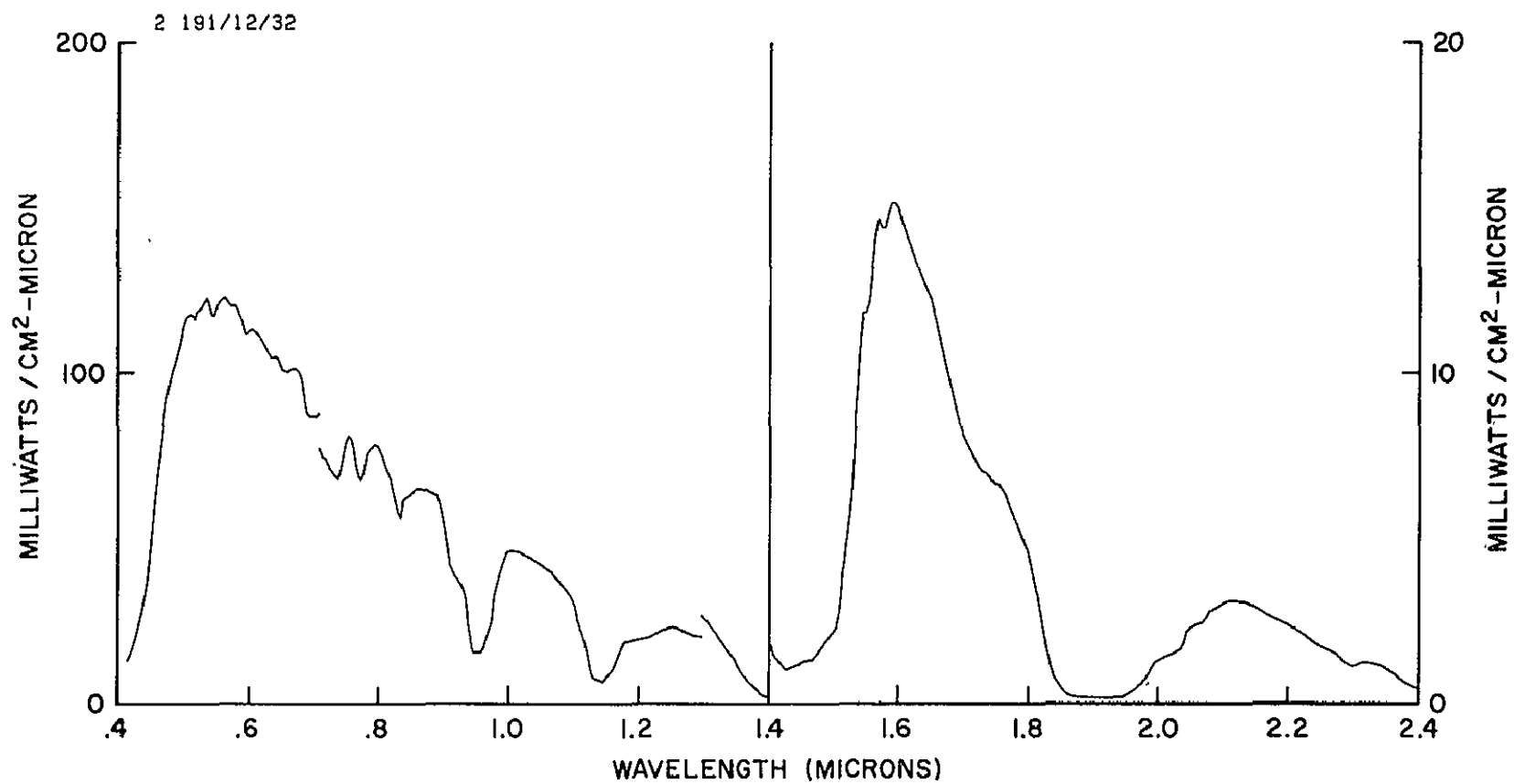
601

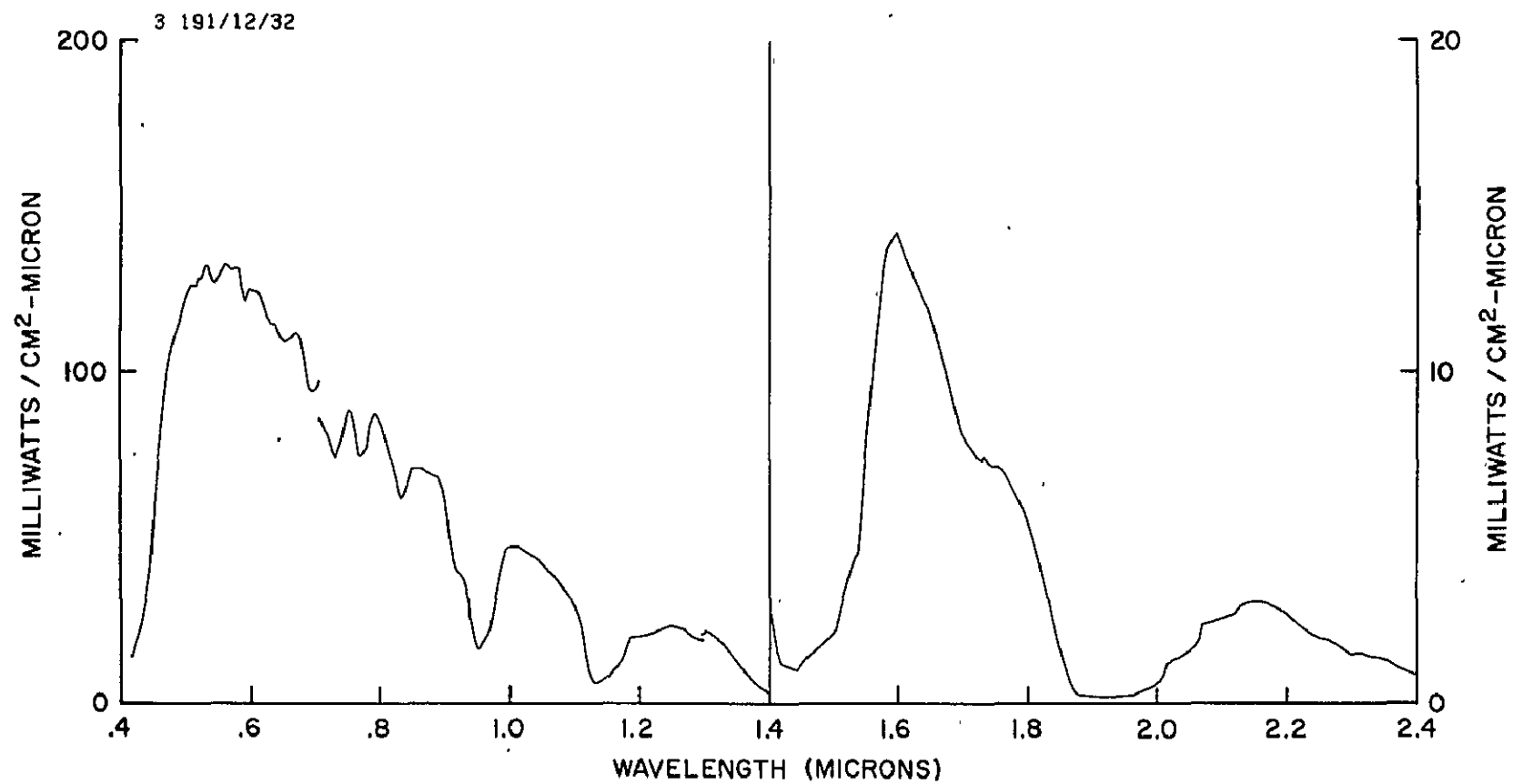


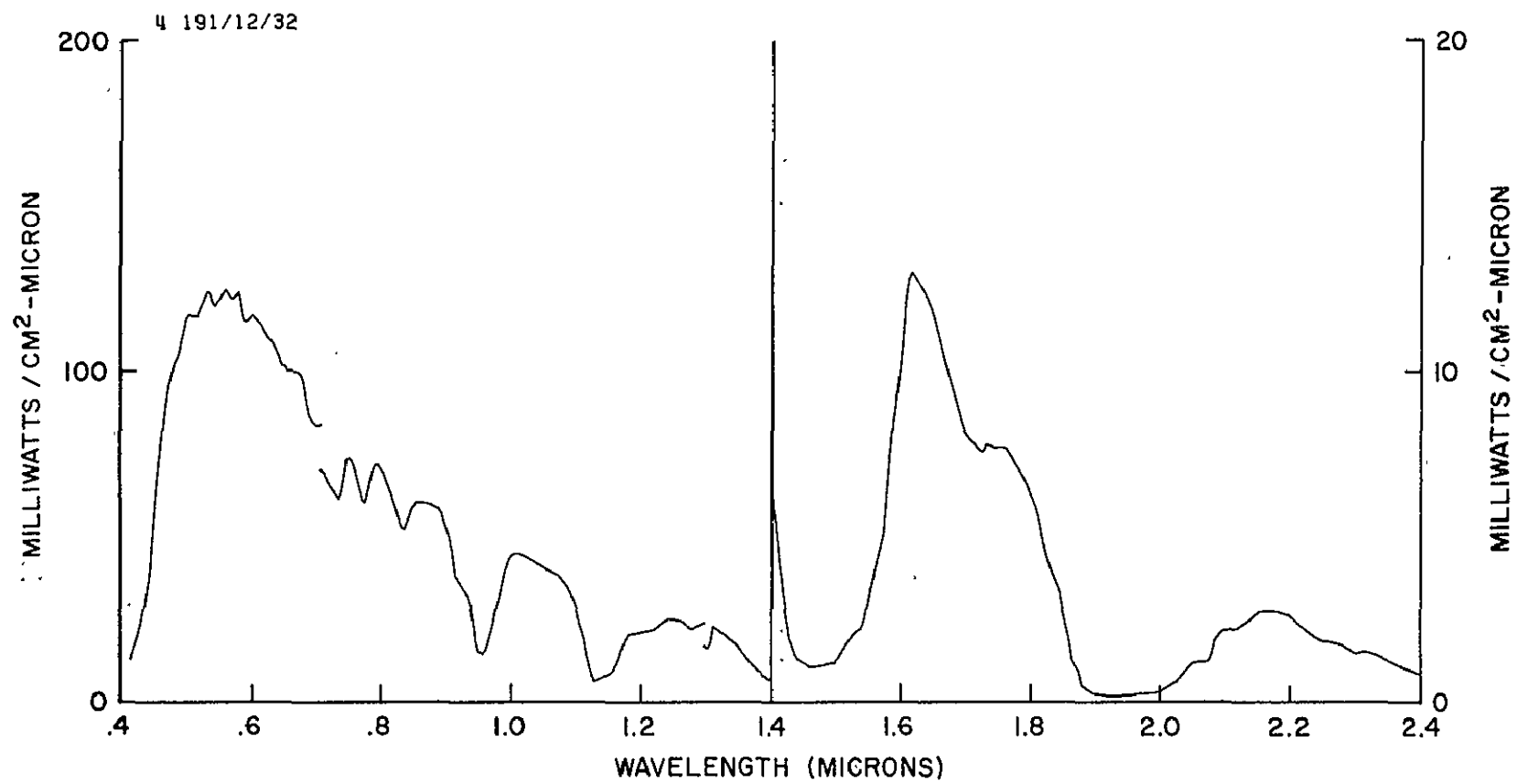


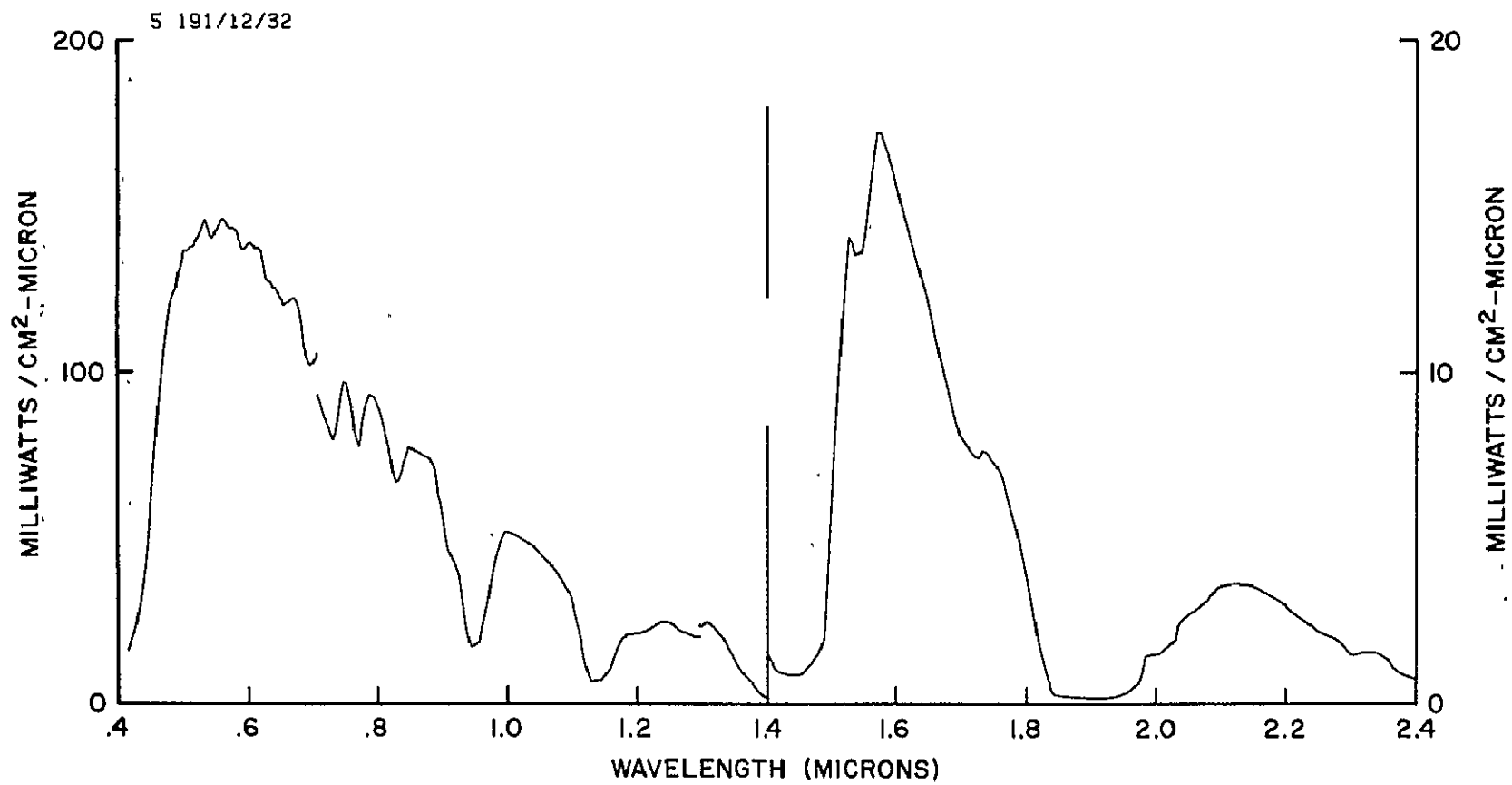












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